Oldman River Dam
Wildlife Habitat Mitigation Program

Preliminary Survey of
Wetland Habitat Projects
1995

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1. INTRODUCTION

The Oldman River Dam habitat mitigation program was developed to minimize the impact and to compensate for the wildlife habitat lost through the flooding of the Oldman River Dam Reservoir.

Prior to flooding of the reservoir, waterfowl and Canada geese were noted to nest and stage along the Oldman, Crowsnest, and Castle river (Young et al. 1986). To replace this lost wetland habitat for waterfowl, as well as to provide a water source for other wildlife and for the irrigation of planted tree and shrub seedlings, numerous wetland creation and enhancement projects were developed on the mitigation land base (Green et al. 1992).

Thirty three check dams and dugouts were constructed in upland sites. Fifteen riparian dams were constructed to provide stable wetlands along the perimeter of the reservoir. Ten riparian dikes and terraces were also constructed along the reservoir edge to provide new riparian bottom-land habitat (Nilson and Green 1989). An initial assessment of selected wetlands projects was undertaken in 1995 to determine whether they were performing according to design, and to record wetland vegetation development. This information will aid in determining if these projects are providing appropriate wetland habitat compensation, and to identify any problems with these projects that may require correction.

1.1 Objectives

The objectives of the 1995 field survey were to identify the current state of vegetation development at selected wetland projects and to evaluate these projects and the vegetation colonizing them in terms of their wildlife habitat value.

2. METHODS

2.1 Sites included in the assessment

The wetlands were inventoried during September and early October of 1995. Only wetland projects with existing as-built site maps (1990, 1:500 scale) were included in this assessment. In total, twenty-seven projects were surveyed including twenty-three check dams, two riparian check dams, and two riparian dikes (Figure 1).

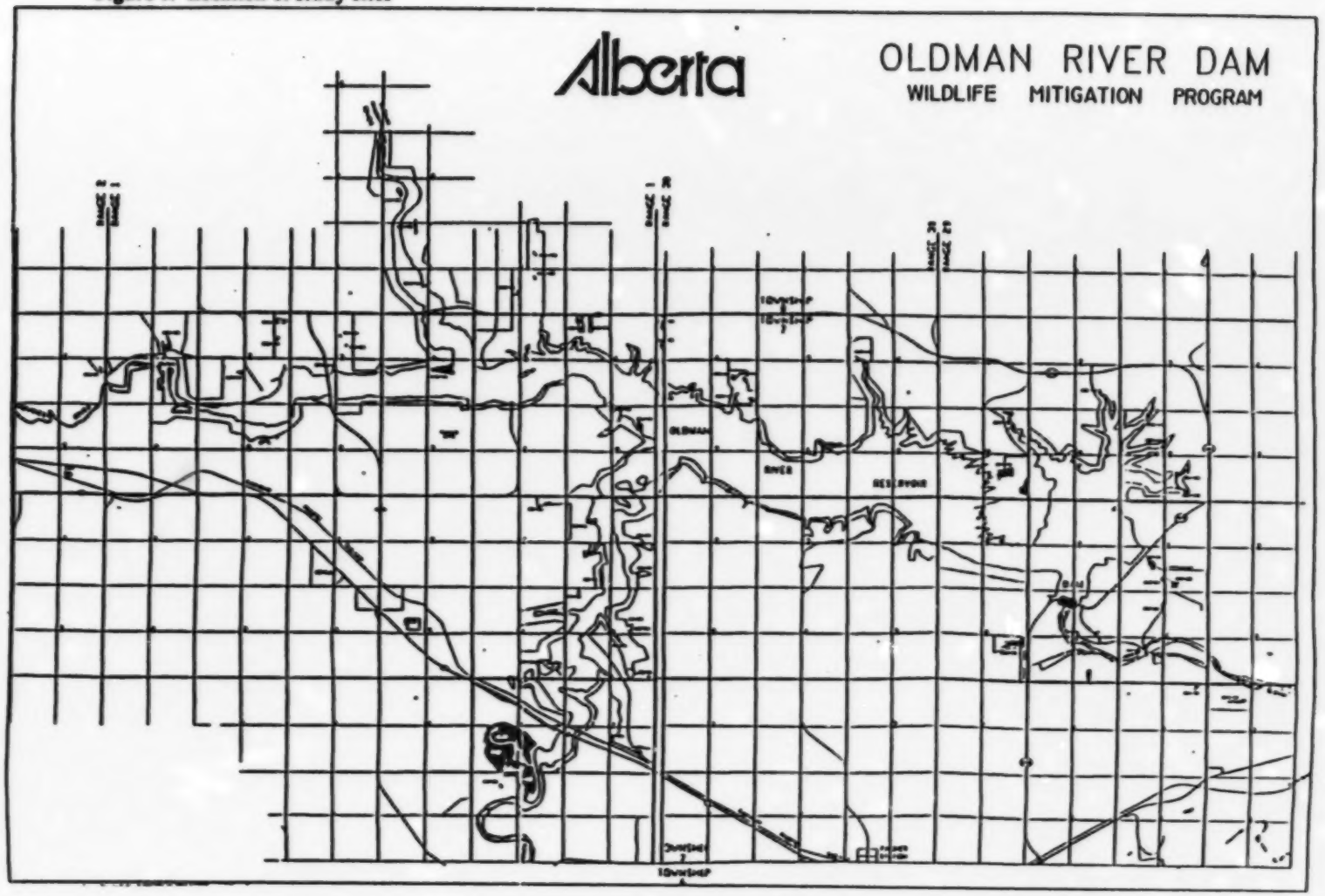
2.2 Photographic survey

In addition to the field assessment of wetlands, an aerial photographic survey covering most of the wetlands within the mitigation land base was done on September 9, 1995 (Appendix III). Additional photographs of selected wetlands, incidental wildlife photographs, and other wildlife habitat related photos were also taken in the field at the time of assessment (Appendix III).

2.3 Field inventory

Prior to the site visit, photocopies of existing as-built site maps were updated using recent air photos (August 4 1995, 1:10,000 scale).

Figure 1. Location of study sites



At each site, the water level at the time of survey was estimated using the method outlined in Appendix A. The estimated water level and the major wetland vegetation zones present within the wetland area of each site were sketched on to the site maps (see Appendix IV for data sheets and site maps). The wetland area was defined as the portion of the basin lying within the outer limits of spring flooding (Millar 1976). In natural prairie wetlands, the outer edge of the Wet Meadow vegetation zone can be used to delineate this (Millar 1976). This zone consists of low grasses, fine sedges and forbs, and is normally flooded for only 3 or 4 weeks in the spring. Because distinct Wet Meadow zones were not present in these created wetlands, the wetland boundaries were ascertained using other visual clues including high water marks on steeper banks and vegetation, and indicative changes in vegetation composition.

Three generalized wetland vegetation zones were used to describe the wetland area in these projects including an Open Water / Aquatic vegetation zone, an Emergent vegetation zone, and a Marsh / Shore vegetation zone. The Open Water / Aquatic zone, based on the Shallow Open Water zone of Millar (1976), is usually flooded year round and includes algae and submergent and floating aquatic macrophytes. The Emergent zone (Emergent Deep Marsh zone of Millar (1976)) is usually inundated from spring through fall (and occasionally overwinter), and consists of tall, coarse vegetation including cattails and bulrushes. The combined Marsh / Shore zone included some traditional Wet Meadow vegetation zone species, as well as species common to Millar's Shallow Marsh zone (mid height grasses, coarse sedges, usually inundated from spring to mid summer or early fall), and pioneer species of Millar's Disturbed wetland zone (Millar 1976). In natural wetlands, these zones and the assemblages of species within them are generally stabilized, and reflect long term moisture conditions of the wetland (Millar 1976). In disturbed (or in this case newly created) wetlands, the occurrence of species identified with zones in natural wetlands is often the result of fortuitous events such as the availability of propagules or suitable moisture conditions for that species at the time of establishment. The resulting species assemblages can not be reliably associated with habitat situations (Millar 1976). Because of this, the combined Marsh / Shore zone was used to describe all remaining non-emergent vegetation up to the wetland area boundary. The percent coverage of the total wetland area occupied by these three zones was visually estimated from an elevated vantage point adjacent to the wetland. Aerial photos of the wetlands taken on September 9, 1995 were also used to confirm and/or aid in these estimations (Appendix III). The following vegetation cover classes were used: (0) = 0%, (1) = trace to 5%, (2) = 6 to 25%, (3) = 26 to 50%, (4) = 51 to 75%, and (5) = 76 to 100%.

A rough description of aquatic vegetation communities was obtained by identifying the main species visible from shore at the time of survey, and ranking these according to their apparent abundance. Emergent vegetation species and Marsh / Shore zone species were also recorded, and approximate percent coverage of these was visually estimated at several different points around each wetland. Based on this information, five main dominant species were identified for the combined emergent, and Marsh / Shore zone of each wetland (see Appendix II for species list and dominance ranking for wetland area species at each project). Dominant species are those that define the character of the vegetation communities more than other species present (Kentula et al. 1992). When ranked in descending order of abundance and cumulatively totaled, the dominant species should exceed 50% of the total percent cover of vegetation for that stratum, and should also include additional plant species comprising 20% or more of the total cover for that stratum (Federal ICWD 1989, in Kentula et al. 1992). Although the amount of "five" main dominant species was arbitrarily chosen to simplify vegetation descriptions of each site, in almost all cases, this amount also fulfilled the above mentioned 70% cover criterion for the vegetation present within the wetland zone. The major vegetation types immediately outside the wetland area and on the

adjacent uplands were also identified during the site inspection. Brief species lists and estimates of percent cover and average height of the dominant vegetation in these areas were also recorded (Appendix 1V).

Additional information was collected during the site visits including descriptions of physical characteristics of the wetlands, qualitative descriptions of water color and clarity, and notes on the presence and relative abundance of aquatic invertebrates. Direct and indirect wildlife observations were recorded for each site. The status of existing habitat mitigation efforts in the vicinity of the wetlands was also noted.

2.4 Evaluating wetland projects

Several factors affecting vegetation development and wildlife use were taken into consideration when evaluating the wildlife habitat value of these wetland projects and the vegetation colonizing them. These factors include type and physical characteristics of the created wetlands, and specific habitat requirements of wildlife commonly associated with natural wetlands of this area.

2.4.1 Wetland type

The type of natural wetlands that these created wetland projects most closely resemble, and their potential value to waterfowl and other wildlife are discussed.

Individual waterfowl species utilize a variety of different wetland types to fulfill their requirements for survival and reproduction (Fredrickson and Reid 1988). Small isolated ponds may act as pairing territories, while other seasonally flooded wetlands may provide feeding sites and brood rearing habitat. Large semi-permanent and permanent marshes with extensive stands of emergent cover are essential to flightless adult birds during the molting period. Large open saline lakes can provide migration and staging habitats for various waterfowl species (Swanson and Duebbert 1989). Large semipermanent wetlands that contain vast areas of emergent vegetation interspersed with open water, as well as shallow marsh, wet meadow, and low prairie vegetation provide ideal habitat for waterfowl and other wetland wildlife (Weller 1981).

2.4.2 Physical characteristics

Some specific topographic parameters of the created wetlands including size, depth, bank slope, and shoreline configuration were noted in the field and from the site maps, and their influence on vegetation establishment and wildlife use is discussed. Table 1 briefly outlines some of the structural characteristics that make created wetlands suitable for vegetation colonization and wildlife use.

Seasonal hydrology and water chemistry (salinity) also play a very important role in wetland vegetation development (Neill 1993). These factors also directly affect invertebrate production (Fredrickson and Reid 1988). Invertebrates play an important role in nutrient cycling within wetland ecosystems (Eldridge 1990). They are also an important food source for amphibians, waterfowl, shorebirds, and numerous other wildlife species attracted to wetlands (Fredrickson and Reid 1988). Hydrology, water chemistry, and invertebrate populations were not measured in this preliminary assessment. However, the suitability of the submergent and emergent vegetation at these wetlands for invertebrate production is briefly discussed.

Table 1. Some structural characteristics of created wetlands that influence the development of wetland vegetation and the use of these wetlands by wildlife.

Variable	Conditions suitable for vegetation colonization and wildlife use
Size	Wetlands constructed for wildlife habitat should be between 0.4 and 4.0 ha in size, with those between 0.4 to 2.0 ha considered optimal for waterfowl. Those smaller than 0.1 ha are considered to be of little use to wildlife (Green et al. 1986)
	Ducks do not use ponds much smaller than 1 ha for brood rearing, unless the food supply is exceptional or the pond is associated with a larger wetland complex (Ducks Unlimited nd).
	Canada geese do not usually use wetlands under 1 ha in size (Green et al. 1987).
Depth & bottom contours	Water depth is one of the most important factors in determining vegetation development in a wetland (Robel 1962).
	Submergent aquatic vegetation can grow in water depths ranging from 0.5 to 5 m. Emergent vegetation is generally found in water under 1.5 m deep, but most species grow best in depths less than 0.5 m (Allan et al. 1989).
	Water depth also influences wildlife use of a wetland (see Table 2 for some water depth preferences of selected wetland species).
	An irregular topography within an impoundment results in ideal water depths for a variety of species (Fredrickson and Taylor 1982)
	Variable depths with at least 50% of the basin shallower than 1.5 m are recommended in order to provide a good interspersion emergent vegetation and open water (Green et al. 1986).
Bank slope	Variable shoreline slopes are recommended to increase interspersion of littoral and deep water zones. Gradual slopes of 10:1 - 20:1 are recommended to promote vegetation growth in littoral areas (Green et al. 1986).
	Steep bank slopes offer less area at the appropriate depth and hydrology suitable for the establishment of wetland vegetation, resulting in a narrow peripheral fringe of emergent species (Kentula et al. 1992).
Shoreline configuration	Ponds and wetlands created for wildlife should have irregular rather than simple shorelines (Green et al. 1986).
	Convoluted shorelines and associated vegetation cover reduce wind and wave erosion, and provide a good interspersion of feeding and loafing sites for water birds and muskrats (Green et al. 1986).
	Peninsulas and bays provide increased edge, littoral areas, and depth heterogeneity resulting in increased habitat diversity and wildlife production (Green et al. 1986).
	Broadly shaped wetlands are preferable to long narrow ones as they can accommodate a greater variety of bottom contours (Ducks Unlimited nd).
Substrate	A bottom substrate with a minimum of 20% clay is recommended for the wetland basin to hold water. Substrates should also be suitable for the growth of wetland vegetation (Green et al. 1986).
Seasonal Hydrology	Hydrologic regime is an important control of primary production in wetland ecosystems (Neill 1993).
	Distribution and successional role of emergent species in prairie wetlands is influenced by the interaction between seasonal water level variations and various ecological life history traits of each species (Van Der Valk 1981, Shay and Shay 1986).

2.4.3 Vegetation development

The type, amount, and general structure of vegetation colonizing the wetlands and adjacent land were evaluated in terms of their value as food and/or cover to a variety of key wildlife types expected to utilize these habitat projects. This was done on an extremely limited and generalized level, as an extensive list of both wetland and terrestrial wildlife species could potentially utilize these wetland projects (see Westworth and Brusnyk 1985, Young et al. 1986). A detailed habitat evaluation for even a few of the potential species is beyond the scope of this assessment. Instead, wetland vegetation is briefly evaluated in terms of the preferred species composition and / or vegetation structure of a few prominent vertebrates that require wetlands to fulfill part or all of their habitat requirements. These include amphibians, waterfowl, shorebirds, wading birds and muskrats. Some general vegetation, water depth and food requirements of these wildlife types are listed in Table 2. General nesting site characteristics of some wetland associated bird species which occur in this area are listed in Table 3. The suitability of vegetation cover for other prominent grassland or shrubland associated species that utilize wetlands as a source of drinking water, food or cover is also discussed briefly in this report. These animals include: songbirds, upland game birds, raptors, deer, coyote, fox, weasel, rabbit, mice, voles, and numerous others.

2.4.4 Upland vegetation and land use

Use of adjacent upland is another factor which may limit the use of wetland projects by wildlife. Air photos were used to estimate the percent cover of major vegetation types and land use of the surrounding area and uplands within a larger, 300 m radius of the check dam ponds. Although some waterfowl species occurring in the Oldman River Dam area may nest up to 1 K or more away from a wetland, 300 m is generally considered the maximum nesting distance away from a pond that the majority of dabbling duck species would likely be found (Watson, pers. comm. 1995). Kentula et al. (1992) also recommend a minimum distance of 300 m around the site for estimating % of surrounding land use when assessing wetland projects.

Table 2. Food types, water depths and vegetative characteristics that attract vertebrates to wetlands

Vertebrate group	Species[a]	Foods[b]	Water depth (cm)	Vegetative structure and composition		
				Height	Density	Cover[c]
Amphibians	Boreal chorus frog, Wood frog, Spotted frog, Northern leopard frog, Western toad, Tiger salamander	I	0-20	short	sparse	open water, mud flats, wet meadow vegetation
Reptiles	Western painted turtle, Garter snakes	I, V	0-50	tall- short	dense-sparse	open water, mudflats, emergent cover, partly submerged logs and rocks for basking (turtle), rank vegetation
Geese	Canada goose	S, E, T	0-10	short	variable	mudflats, herbaceous, rank, seed producing annuals, green forage and crop species on upland
Dabbling ducks	Mallard, Pintail, Gadwall, Teal, Northern shoveler, Widgeon	I, S, A	5-25	short	sparse	open water with submergent vegetation, hemi-marsh[d] emergent cover preferred, exposed shorelines and mudflats
Diving ducks	Bufflehead, Goldeneye, Ring-necked duck, Red-head, Canvasback	I, S, A	25+	short	sparse	larger open water areas with abundant aquatic vegetation for feeding, openings in marsh canopy
Grebes	Pied billed grebe, Horned grebe, Eared grebe	I, V	25+	short	sparse	open water, dense to open cover depending on species
Coots	American coot	S, A, I	28-33	short	sparse	open water and aquatic vegetation
Shorebirds	Plover, Killdeer, Curlew, Sandpiper, Snipe, Yellowlegs, Avocet, Phalarope	I	0-7	short	sparse	mudflat, shallow open water, occasionally upland, most prefer vegetation cover no more than half their height
Wading birds	Great blue heron, American bittern	V, I	7-12	short	sparse	shallow open water
Rails	Sora rail	I, S	5-30	medium	dense	sedges
Semi-aquatic mammals	Muskrat	E, A, I, T, V	50-150+	tall	dense	emergents for food and lodge building material, submergents for food, shrubs or dense vegetation to stabilize banks, water over 0.7 m deep to over-winter in

Source: Modified from Fredrickson and Taylor (1982), Weller (1981). Muskrat information from Green et al. 1987.

[a] *Some of the species that have been observed or that are likely to occur as residents or migrants in this region, from Green et al.1992, based on Westworth and Bruzyk 1985 and Young et al. 1986.*

[b] *I = invertebrate, V = vertebrates, S = seeds/achenes (terrestrial, emergent and/or aquatic), A = aquatic plant matter (leaves, rootstocks), E = emergent plant matter (leaves, rootstocks), T = terrestrial plant matter*

[c] *General cover requirements, cover at foraging sites. Nesting cover requirements listed in table 3.*

[d] *A "hemi-marsh" phase occurs when emergent vegetation and open water cover approximately equal areas of a wetland in a highly interspersed manner (Weller and Spatcher 1965, Weller and Fredrickson 1974).*

Table 3. General nesting site preferences of some wetland associated birds of this area

Type / Species	Nest site	Vegetation structure		Vegetation type / Substrate	Distance from Wetland
		Height	Density		
Dabbling ducks					
Mallards	upland/pasture	tall (>0.5 m)	dense	herbaceous, mixture of grass, legumes, low shrubs; planted cover	usually within 200 m, but up to 3 km from wetland
Blue winged teal	upland/wet meadow	medium-tall	dense	grasses and sedge meadows; herbaceous vegetation; moderately grazed pasture	variable, from water up to 1.6 km from wetland
Northern pintail	upland	short	sparse	open shortgrass prairie; moderately grazed pasture	up to 3 km from water
Gadwall	upland	tall	dense	herbaceous vegetation or small shrubs; planted cover	usually within 300 m from wetland, up to 3 km
Widgeon	upland/wet meadow	tall	dense	grasses and weeds, similar to Mallard and Gadwall; idle pasture	close to water
Northern shoveler	upland/wet meadow	short-medium	dense	open grassy vegetation, moderately grazed pasture	generally within 1 km of wetland
Wood duck	upland	N/A	N/A	trees or stumps, in cavities made by woodpeckers or internal rot, will use artificial nesting boxes	variable, up to 1.6 km from wetland
Diving ducks					
Red-head, Canvasback	over water	tall (>0.9 m)	dense	broken stands of robust emergent vegetation, preferably cattail and bulrush, occasionally tall grass, sedge cover	over water, in large central patches, or wide peripheral bands of emergents
Ring-necked ducks	wet meadow/ shallow marsh	short-medium	dense	aquatic grasses, sedges on moist substrate without standing water	adjacent to wetland
Bufflehead, Golden-eye	upland	N/A	N/A	trees or stumps, in cavities made by woodpeckers or internal rot, will use artificial nesting boxes	usually nest within 183 m of wetland
Duck-like birds					
Coots	over water	short	dense	low emergent vegetation	over water near water level
Grebes	over water	medium-tall	variable	emergent vegetation	low wet nests at water level

Sources: Swanson and Duebbert (1989), Eldridge (1992), Weller (1981), Fredrickson and Heitmeyer (1991), Fredrickson and Gammonley (1993), Michel-Custer (1993), Ringelman (1990), Interior Region Shorebird Ecology (photocopy from Ducks Unlimited, author and date unknown)

Table 3. General nesting site preferences of some wetland associated birds of this area (continued)

Type / Species	Nest site	Vegetation structure		Vegetation type / Substrate	Distance from Wetland
		Height	Density		
Wading birds					
Great blue heron	upland	tall	dense	upper strata of deciduous and mixed wood tree stands, occasionally in dense emergent vegetation	most colonies located along lakes and streams
American bittern	over water	tall	dense	cattails and reeds	over water, but can nest in upland in drier prairie areas
Passerines					
Red-wing blackbird, Yellow headed blackbird	over water	tall	dense	robust emergents, cattails and bulrush	over water, in central patches or peripheral bands of emergents
Shorebirds					
American avocet	beach/peninsula	short	sparse	open / exposed soil	beaches of saline wetlands
Piping plover	beach/peninsula	none	sparse	open / salt flats, gravel	beaches of saline wetlands
Upland sand piper	upland/prairie	medium /tall	dense	native grassland vegetation	may use uplands not associated with wetlands
Wilson's phalarope, Common snipe	upland/wet meadow	medium	moderate /dense	wet meadow vegetation	adjacent to permanent or semipermanent wetlands
Long-billed curlew	upland/pasture	short	moderate	short, open native grassland vegetation	may nest hundreds of meters away from water
Marbled godwit, Willet	upland/prairie	medium	moderate	open native grassland vegetation	may nest hundreds of meters away from water
Killdeer	upland/beach	none	sparse	open / exposed soil, rocky	may nest hundreds of meters away from water

Sources: Swanson and Duebbert (1989), Eldridge (1992), Weller (1981), Fredrickson and Heitmeyer (1991), Fredrickson and Gammonley (1995), Mitchel-Custer (1993), Ringelman (1990), Interior RegionShorebird Ecology (photocopy from Ducks Unlimited, author and date unknown)

3. RESULTS AND DISCUSSION

In order to simplify the presentation of results and discussion of current vegetation development and wildlife use, the wetlands assessed in this study are grouped into four general categories based on shared topographic features and wetland project types. These four categories are: 1) Narrow dart shaped check dam and riparian dam ponds in steep sided coulees; 2) Small check dam ponds and dugouts with wider shallower basins; 3) Large irregularly shaped check dam ponds in gently sloping depressions; and 4) Riparian dike wetland projects.

3.1 Type 1 wetlands: Narrow dart shaped check dam and riparian dam ponds built in steep sided coulees.

Thirteen of the assessed check dams were built in relatively steep sided coulees. The small, relatively deep, permanent water bodies that resulted include : CR25-C03, OC21-C01, OC26-C01, OC26-C02, OC26-C03, OC05-W01, C19-W01, C19-C01, C26-C01, OC20-C01, OC20-C02, C32-C01 and CR08-C01.

3.1.1 Wetland vegetation

The estimated percent cover of the three main vegetation zones are shown in Table 4. Open water, including floating and submerged algae and aquatic vegetation was the dominant vegetation zone in this group of ponds. At four of these ponds, open water covered approximately 51-75% of the total wetland area. The 9 remaining ponds were even more open, with 76-100% of the total wetland area recorded as open water (Table 4). Algae and/or aquatic vegetation were present at all of these ponds. Two ponds contained only trace to 5% cover of aquatic vegetation (Table 4). One of these (C19-C01) was turbid with suspended single celled algae, and sediment from unrestrained cattle usage. The other (C19-W01) was turbid with suspended sediment and the aquatic vegetation was not present or visible as a result of the check dam breaking during the flooding in June 1995. The majority of ponds (7) fell within the 6-25% cover class for aquatic vegetation. The remaining four ponds had more visible aquatic vegetation, with three in the 26-50% range and one in the 51-75% range. Filamentous algae, (likely of the genus *Cladophora*, and less commonly *spirogyra*) were noted at almost all ponds but did not appear to be overly abundant in any of these. Macrophytic algae of the genus *Chara* was also noted in more than half of these ponds (Table 5). The three types of submergent aquatic plants that were most often dominant at these ponds were: 1) clasping leaf pondweed (*Potamogeton richardsonii*); 2) *Potamogeton spp.* which included various similar looking thin-leaved pondweeds such as *P. filiformes, P. foliosus. P. pectinatus, P. pusillus,* and *P. zosteriformes* (these were grouped together as both species and dominance were impossible to identify using the visual estimation method employed in this preliminary survey), and 3) northern watermilfoil (*Myriophyllum exalbescens*)(Table 5).

In almost all of these ponds, some emergent vegetation is present, and at some, sparse peripheral bands of vegetation are becoming established. The only true emergent species (as defined by Millar) found in this type of pond were the common cattail (*Typha latifolia*) noted at 12 ponds, and bulrush (*Scirpus sp.*, most likely *S. acutus* and/or *S. paludosus*) seen at only 3. These species occurred as scattered individuals or small patches and occasionally as larger denser patches ranging from the newly exposed mud flats along the waters edge to roughly 3 m out in the water. Half of these ponds had only trace amounts to 5% cover of emergent vegetation. The other half were listed as having between 6 and 25% cover (usually falling within the lower end of this range).

Spike rush, (*Eleocharis palustris*) which is classified as a shallow marsh species, was often found in the shallow water with the emergent species.

Shallow marsh species including spike rush (*Eleocharis palustris*), reed canary grass (*Phalaris arundinacea*), slough grass (*Beckmannia syzigachne*), sedges (*Carex sp.* including *C. aquatilis, C. lanuginosa* and *C. rostrata*), and tall manna grass (*Glyceria grandis*) were found either in shallow water (50 cm to 1m out from the shore) or on the recently exposed mud flats along the waters edge. The mud flats were also colonized by opportunistic, moisture tolerant species including northern willow-herb (*Epilobium ciliatum*), redtop (*Agrostis stolonifera*), wild mint (*Mentha arvensis*) and narrow-leaved dock (*Rumex triangulivalvis*). Grassy bands including foxtail barley (*Hordeum jubatum*), timothy (*Phleum pratense*) and bluegrass (*Poa spp.*) also commonly bordered the mud flats. Scattered willow stems were found at more than half of these ponds. The west shore of each pond (which were predominantly in N-S running coulees) usually had a steeper bank, and very narrow (if any) mud flat. This shore, along with the upper, less recently inundated portion of the east shore, was usually dominated by moisture loving agricultural grasses and weeds including bluegrass, quack grass (*Agropyron repens*), awnless brome (*Bromus inermis*), and Canada thistle (*Cirsium arvense*). Riparian shrubs sometimes found in this area included rose (*Rosa spp.*) and buckbrush (*Symphoricarpos occidentalis*).

Table 4. Percent cover[a] of Open Water / Aquatic, Emergent, and Marsh / Shore areas in type 1 wetland

Site I.D.	Flooded area (ha)[b]	Open Water / Aquatic			Emergent vegetation	Marsh / Shore		
		Total cover	Vegetated	Unvegetated		Total cover	Vegetated	Unvegetated
C19 - C01	0.24	4	1	4	1	2	2	2
C19 - W01	-	4	1	4	1	3	2	3
C26 - C01	0.17	4	3	3	2	3	3	1
C32 - C01	-	4	2	4	1	3	2	2
CR08 - C01	0.24	5	3	4	2	1	1	1
CR25 - C03	-	5	3	4	1	1	1	1
OC05 - W01	0.38	5	2	4	1	2	2	1
OC20 - C01	0.22	5	2	4	2	2	2	1
OC20 - C02	0.05	5	2	5	2	1	1	1
OC21 - C01	0.28	5	2	4	1	1	1	1
OC26 - C01	0.22	5	4	3	2	2	1	1
OC26 - C02	0.12	5	2	4	2	1	1	1
OC26 - C03	0.10	5	2	4	2	1	1	1

[a] *Cover classes based on % cover of total wetland area:*

0 = 0% *3 = 26 to 50%*
1 = trace to 5% *4 = 51 to 75%*
2 = 6 to 25% *5 = 76 to 100%*

[b] *Included if figure was provided on as-built survey maps.*

Table 5. Dominant and frequently occurring[a] plant species found in type 1 wetlands

Species and designated zone	Order of dominance	% of wetlands containing these species	Associated vegetation zone[b]	Characteristics of species[c]
Open Water / Aquatic				
Potamogeton richardsonii	1	77	O	FN
Potamogeton spp. (P. filiformis, P. foliosus, P. pectinatus, P. pusillus, P. zosteriformis)	2	54	O	FN
Myriophyllum exalbescens	3	62	O	FN
Cladophora spp., Spirogyra spp.	4	92		LN
Chara spp.	5	54		LN
Callitriche hermaphroditica	6	38		FN
Emergent and Marsh / Shore				
Poa spp. (P. pratensis, P. compressa, P. palustris)	1	100	W	GPI, GAI, GPN
Hordeum jubatum	2	100	W(D)	GPNΨ
Eleocharis palustris	3	100	M	GPN
Typha latifolia	3	92	E	FPN
Agropyron repens	3	77	D(W)	GPIΨ
Phleum pratense	4	100		GPI
Agrostis stolonifera	4	92		GPI
Phalaris arundinacea	5	46	M	GPN
Beckmannia syzigachne	6	54	D(M)	GAN
Bromus inermis	7	92		GPI
Carex spp. (C. aquatilis, C. lanuginosa, C. rostrata)	8	85		GPN
Epilobium ciliatum	9	92		FPN
Glyceria grandis	10	38		GPN
Cirsium arvense		100	W(D)	FPIΨ
Rumex triangulivalvis		77		FPN
Juncus balticus		69	W	GPN
Aster ericoides		62		FPN
Salix spp. (S. exigua, S. discolor & others)		62	W	SPN
Aster laevis		54		FPN
Cirsium vulgare		54		FBIΨ
Deschampsia cespitosa		54	W	GPN
Helianthus spp. (H. annuus, H. nuttallii)		54		FAN, FPN
Mentha arvensis		54		FPN
Rosa spp. (R. acicularis, R. arkansana, R. woodsii)		54		SPN
Symphoricarpos occidentalis		54		SPN

[a] *Occurring in over 50% of this type of wetland. Species with lower occurrence rates are included if they were ranked as a dominant.*

[b] *Species associated with, and at least occasionally dominant in vegetation zones of native wetlands in the grasslands and parklands of western Canada. These zones include:* O = *shallow open water*, E = *emergent deep marsh*, M = *shallow marsh*, W = *wet meadow*, D = *disturbed. (Source: Millar 1976).*

[c] S = *shrub*, F = *forb*, G = *graminoid*, L = *algae*, P = *perennial*, B = *biennial*, A = *annual*, N = *native*, I = *introduced*, Ψ = *in "Weeds of Alberta"*

3.1.2 Surrounding and upland vegetation and land use

The majority of these ponds had a cover of dense forage species up to 1.5 m tall on the east facing slopes bordering the west shore of the ponds. This vegetation type usually extended up to the fence line on the adjacent upland. This cover consisted predominantly of weedy forage grasses, usually awnless brome and/or quack grass, and occasionally bluegrass. It also included other forage species such as alfalfa and sweet clover, weeds including Canada thistle, and scattered low shrubs, including rose and buckbrush. Tree and shrub seedlings planted on these slopes adjacent to the wetlands were most often overgrown by this vegetation, and difficult locate. Those planted seedlings that had survived were often browsed and were usually under 50 cm tall. Three of the ponds, CR08-C01, OC26-C03 and C19-W01 had larger patches of tall native shrub cover on their east facing slopes. Species found in these patches included buckbrush, saskatoon (*Amelanchier alnifolia*), choke cherry (*Prunus virginiana*), woods rose (*Rosa woodsii*), gooseberry (*Ribes spp.*) hawthorn (*Crataegus douglasii*) and occasionally wolf willow (*Elaeagnus commutata*). Some of these shrubs reached heights of up to 3 m tall. The east facing slopes and upland vegetation within the fencing was covered in predominantly shorter, sparser native sloped and upland grassland vegetation.

The approximate percentages of disturbed and undisturbed surrounding and upland vegetation within a 300 m radius of the pond are shown in Table 6. Most of the sites had a relatively small protected area around the wetland, and the surrounding upland beyond the bordering fence was usually under some form of human land usage including forage crops, pasture, roads and farmsteads. Six ponds had between 76% and 85%, and four had between 50% and 67% of this area under some form of human disturbance. At both OC26-C02 and C19-C01, area within the mitigation land base had been grazed. The three remaining ponds had slightly larger protected areas currently within the mitigation land base, and had only 31% to 43% of the designated area under human land usage (Table 6).

3.1.3 Wildlife use

Aquatic invertebrates including a variety of insects, snails, and freshwater shrimp, were observed at all ponds. Chorus frogs (likely *Pseudocris triserata maculata*) were seen at four of these ponds and unidentified amphibian eggs were seen at one other. Small unidentified fish were seen in OC05-W01, which is located on the reservoir edge.

Two or three waterfowl were sighted at each of OC21-C01, OC26-C03, OC20-C01, and CR08-C01. At OC20-C01, a mallard was flushed from the dense forage grass within the fence line on the west side of the pond. Two ponds (C19-W01, C19-C01) had possible shorebird tracks on the peripheral mud flat.

Some passerine nests, likely belonging to red-wing blackbirds were found in the cattails surrounding two ponds (OC26-C01, OC26-C02), and sparrows and other songbirds were either seen or heard in the vicinity of most of these ponds. A red-tail hawk was seen resting on a nest box pole at OC19-W01, and flying over OC20-C02. At OC05-W01 several predator feeding sites littered with bird feathers and bones were seen on the mud flats, and a raptor (most likely a marsh hawk) was accidentally flushed off one such spot on the marshy north end of the pond. On a later visit to this pond, scattered feathers and a mallards wing were found on the waters edge on the west shore (see photograph in Appendix III). At OC26-C02, a predator feeding spot littered with the feathers of a songbird were found.

Table 6. Estimated % area[a] of upland usage and general vegetation types within a 300 m radius[b] of type 1 wetlands

Land use / vegetation type	Site I.D.												
	C19 - C01	C19 - W01	C26 - C01	C32 - C01	CR08 - C01	CR25 - C03	OC05 - W01	OC20 - C01	OC20 - C02	OC21 - C01	OC26 - C01	OC26-C02	OC26 - C03
Wetland(s)	1	1	<1	1	1	2	4	2	2	1	1	<1	<1
Reservoir or river		3			3		5						
Total % of area covered by water:	1	4	<1	1	4	2	9	2	2	1	1	<1	<1
Treed slope			3		5								
Tall shrubs with forage understory		2	<1		1			3	<1	2		1	
Uncut forage with some low shrubs	2	19	2	27	2	6	9	13	12	7	31	1	14
Ungrazed grassland	12	37	17	5	21	41	51	6	6	6	25	19	36
Total % of land area undisturbed:	14	58	23	32	29	47	60	22	18	15	56	22	50
Grazed grassland / pasture	85	38	63		59	10		59	67			33	
Hayed forage cropland			14	63		41	28	10	7	84	43	45	49+
Roads				4	3			5	4				
Farms					1			2	1+				
Bare shore line							3						
Gravel quarry					4								
Total % of land area disturbed:	85	38	77	67	67	51	31	76	80	84	43	78	49+

[a] *Based on 1995 (1 : 10,000 scale) air photos, with the exception of C19-C01, and OC26-C02. These sites were not photographed in this series, so existing 1990 air photos were used instead.*

[b] *From center of wetland basin.*

Muskrats were seen swimming or feeding at 3 of the ponds, and evidence of muskrat use including tracks, dens, and feeding damage on emergent vegetation were noted at 5 other ponds. Emergent vegetation is not abundant at these ponds so characteristic muskrat lodges made of cattails and other emergent vegetation were not noted. When emergent vegetation is limited, dens are constructed in stable banks, with entrances under water (Fuller 1951). This type of den was noted on the west shoreline at the two riparian check dam ponds. Smaller microtine rodents such as voles and mice were occasionally sighted, and likely thrive in the thick growth near these ponds.

Coyote tracks were noted at five of these wetlands. Coyotes likely frequent these ponds for a ready source of both drinking water and small prey animals. A red fox was seen traveling between OC26-C01 and OC26-C02. Mule deer, and likely white tail deer currently use these ponds as a source of drinking water, and food. Mule deer were seen at two sites, and deer signs including tracks, droppings, browsed shrubs, and deer trails leading to the waters edge were specifically noted at eight of the sites. Patches of flattened vegetation where deer rested or slept were also commonly noted in the thick forage grass adjacent to the ponds and on the leeward side of snow fences erected to increase moisture for the mitigation plantings.

3.1.4 Evaluation of type 1 wetlands

Wetland type

These small, relatively permanent ponds are most similar the Shallow Open Water wetland type described by Millar (1976) for wetlands of natural origin. This type is defined as having over 56% of the wetland area (75% of the diameter) covered by the Shallow Open Water zone, and having emergents confined to a narrow marginal band (Millar 1976).

Physical characteristics

At the time of the survey, all type 1 wetlands held water. C19-W01 held less water than it is capable of as a result of a break in its dam caused by the flooding in June of 1995.

The wetlands in this group (with size information provided) ranged between 0.05 and 0.38 ha in size, and were on average 0.2 ha in size (Table 4). This is smaller than both the optimum size range for waterfowl, and the suggested size range for wetland construction for wildlife use.

These ponds all have relatively straight, simple shorelines. Their narrow shape does not allow for a diversity of bottom contours necessary for a good interspersion of emergent vegetation and deeper open water. Four ponds had bottom contours present on the as-built site maps, and these showed maximum depths (at FSL) of between 2 and 4 m deep. Three of these ponds appeared to have sufficient portion of their bottom contours shallower than 1.5 m deep to allow the development of up to 50% cover of peripheral emergent vegetation (if seasonal hydrology and other factors influencing this are suitable). The remaining 9 ponds were full or partially full of water at the time of survey, so the exact bottom contours and depths are unknown. Based solely on observation, it appeared that these ponds were also equally deep centered, and that the bank slopes were also sufficiently steep to limit emergent vegetation development to a peripheral band. The bank substrate appears to be suitable for muskrats to build dens, and the water depths are sufficient to allow them to over-winter in these ponds. The optimal emergent cover for muskrats is 25 to 75% with the remainder covered in open water submergents (Eccles et al. 1988). The amount of emergent cover at these ponds ranged from trace to 26% of the wetland area, and

submergent vegetation covered slightly more than this. Muskrats currently utilize the limited emergent vegetation, and their presence or absence will likely influence the potential of these ponds to develop a greater cover of emergents in the future.

These ponds are currently used by a variety of waterfowl at least for the purpose of feeding, and resting. The largest of these ponds, OC05-W01 was among those surveyed for waterfowl in the spring of 1995, and on April 28, 2 mallards, 13 gadwall, 5 shoveler, 5 bufflehead, 4 widgeon, and 3 green-winged teal were seen at this site (Fyfe 1995). This is one of the two "riparian" check dams directly off of the reservoir, and the only pond noted to contain fish.

In general, the value of these ponds for waterfowl production may be limited as a result of their relatively small sizes, steep bank slopes, limited shallow areas, and lack of emergent vegetation and shoreline diversity. However, these small ponds may still provide additional habitat to a small number of breeding waterfowl pairs seeking out isolated ponds to avoid competition on larger more crowded lakes and marshes. These relatively permanent ponds may also become more valuable to breeding waterfowl in drier years when other currently more suitable areas are not available. The lack of dense emergent vegetation cover at these ponds currently makes them unsuitable for overwater nesting birds, including many diving ducks which might otherwise take advantage of the deeper water, aquatic vegetation (and at one site, fish) that are present at these ponds. Habitat suitable for cavity-nesting ducks is also very limited in the vicinity of these ponds. At the two sites where artificial nesting structures were placed (OC05-W01 and C19-C01), the nesting boxes and poles they were mounted on had fallen into the water. The lack of extensive mud flats and shallow shoreline areas may limit the use of these ponds by frogs and shore birds. The lack of shallows, and limited occurrence of larger prey species such as fish and chorus frogs likely makes these ponds less attractive to larger wading birds such as great blue heron.

Vegetation development

A variety of useful species of aquatic vegetation has colonized these ponds and are currently providing valuable habitat for a good selection of aquatic invertebrates. These invertebrates are valuable as food for birds and amphibians, and the aquatic plants themselves are useful as both waterfowl and muskrat food. Emergent vegetation is currently sparse but will likely increase in time if water levels are slightly lower than seen in this particularly moist year. At these ponds, cattails were noted more often than bulrushes. This may likely be due to hydrological conditions or limited seed sources, but may also be partly explained by a strong food preference for bulrush (*Scirpus acutus*) by muskrats, that has been documented in southern Alberta (Welch 1980). The shoreline on the edge of these ponds is generally somewhat barren as a result of the relatively steep bank slopes and wind and wave erosion. The vegetation commonly growing in the upper portion of the shoreline zone largely consisted of disturbance species. Many of the dominant and commonly occurring species were also introduced rather than native species, and the second and third most commonly dominant species (quack grass and foxtail barley), are considered to be problem weeds in Alberta (Stearmen 1983). These species are currently useful as cover, but they are invasive and may eventually out-compete other more useful native sedges and grasses that have greater nutritional value for birds and wildlife. Patches of tall weeds such as Canada thistle and agricultural species such as alfalfa and sweet clover on the dam or in the periphery of the wetland are useful as food for deer, food and cover for songbirds and rodents, and hiding and nesting cover for waterfowl.

The extremely dense cover of forage species commonly present on the east facing slopes is within the appropriated height range for nesting ducks (over 0.5 m), but may be too dense and monospecific in some sites to be used by them for this purpose. Ducks prefer heterogeneous cover with an interspersion of shrubs, weedy species, and dense grass (Klett et al. 1984, Duncan 1986). As well, the relatively steep angle of most of the slopes may also limit their use for duck nesting. The mitigation shrub plantings on these slopes were doing poorly as a result of shading and competition from this dense grass cover. In sites where native tall shrubs were present, these stands received heavy deer use for browse and cover, highlighting the importance and relative scarcity of tall shrub habitat in this area.

The grassland vegetation present on the west facing slopes was shorter and sparser than that seen on the moister east facing slopes, and often contained bare eroded patches. This sloped grassland vegetation, which also included some rose and buckbrush shrubs, will likely increase in density and cover in time as this area continues to be protected from cattle grazing. Native vegetation is extremely important to birds and other wildlife for food and cover. For many grassland songbirds, the composition of species at a site has been shown to be more important than the vegetation structure (Rotenberry 1985). In the reservoir area, undisturbed native grassland vegetation is rare due to loss through agricultural development and invasion by aggressive agricultural species.

Upland vegetation and land use

These projects have relatively small protected areas surrounding the wetlands. On average, over half of the land within a 300 m radius of the wetland center is either grazed grassland or hayed forage cropland (Table 6). Both of these activities can limit waterfowl nesting success. Most of these ponds are also used by cattle for drinking water. At two sites (OC26-C02 and C19-C01), cattle use was not adequately restricted to the designated walkways. This resulted in grazing and trampling damage of emergent and shore vegetation, and severe overgrazing (almost to the point of soil erosion) of the adjacent slopes and upland within the designated protected area. At OC26-C02, several bird nests were found completely exposed or submerged under water as a result of trampling and grazing of the cattails surrounding the pond. At both sites, the water was murky with suspended sediments and planktonic algae. Tall shrubs on the east facing slope were also damaged by the cattle. Fortunately, restricting or removing cattle access in these areas will likely allow these areas to fully recover, as seen at C26-C01. This wetland area was accidentally grazed and damaged by cattle in 1994. In late 1995, after a season with cattle access limited to the walkway, water quality had improved, and aquatic, emergent, and surrounding vegetation was recovering substantially.

3.2 Type 2 wetlands: Small, wider wetlands built in relatively shallow basins

Seven of the check dams were built in slightly wider, shallower basins. These include : OC21-C02, C20-C01, CR25-C01, CR25-C02, C32- "small", C19-C02, and C26-C02. The majority of these ponds are relatively small, slightly rounded and/or almost equilateral triangular in shape. Out of these, C19-C02 and C26-C02 did not hold the amount of water that they were intended to. Two ponds differed in shape from these, but were included in this group because of their wider, shallower basins. The largest of these ponds, OC21-C02, is more elongate in shape than the others, and is found in a coulee similar to the type 1 ponds. The other, CR25-C01, is a rectangular shaped dugout.

3.2.1 Wetland vegetation

Open water including algae and aquatic vegetation, was also the dominant vegetation zone in this type of wetland. Of the ponds that held water, three of these had between 76-100% of their area up to FSL as open water, and one had 51-75%. The small pond at C32 had only 26-50% of its area as open water due to its extremely small size and total surface area. Of the two other ponds that did not hold the amount of water they were intended to, C19-C02 held some water (falling into the lower end of the 26-50% range) while C26-C02 did not hold any (Table 7).

Table 7. Percent cover of Open Water / Aquatic, Emergent, and Marsh / Shore areas in type 2 wetlands

Site I.D.	Flooded area (ha)[b]	Open Water / Aquatic			Emergent vegetation	Marsh / Shore		
		Total cover	Vegetated	Unvegetated		Total cover	Vegetated	Unvegetated
C19 - C02	0.09	3	1	3	0	4	3	3
C20 - C01	0.27	5	2	4	2	1	1	1
C26 - C02	0.15	0	N/A	N/A	N/A	5	4	3
C32 "small"	-	3	2	2	2	3	2	2
CR25 - C01	0.10	5	4	3	1	1	1	1
CR25 - C02	0.08	5	3	3	2	1	1	1
OC21 - C02	0.32	4	3	2	2	2	2	1

[a] *Cover classes based on % cover of total wetland area:*

0 = 0% *3 = 26 to 50%*
1 = trace to 5% *4 = 51 to 75%*
2 = 6 to 25% *5 = 76 to 100%*

[b] *Included if figure was provided on as-built survey maps.*
N/A = Not applicable.

In those that contained water, aquatic vegetation covered 6-25% of the wetland area in two ponds, and 26-50% in two others. In one pond, aquatic vegetation covered 51-75% of the wetland area (Table 7). Filamentous algae including *Cladophora sp.* and *Spirogyra sp.* were present in all of these ponds, and macrophytic algae (*Chara sp.*) was seen in slightly over half. The aquatic vegetation seen at these ponds included *Potamogeton spp.* (*P. filiformis*, *P. foliosus*, *P. pectinatus*), *Potamogeton richardsonii*, and *Myriophyllum exalbescens*. *Potamogeton spp.* and *Chara sp.* were the two most commonly dominant species (Table 8).

All type 2 wetlands that held water had some emergent vegetation cover. One had only trace to 5% cover, while the remaining four had 6 to 25% (Table 7). *Typha latifolia*, an emergent species, and *Eleocharis palustris* and *Phalaris arundinaceae* two shallow marsh species were among the plants listed as being commonly dominant within the wetland area (Table 8).

Table 8. Dominant and frequently occurring[a] plant species found in type 2 wetlands

Species and designated zone	Order of dominance	% of wetlands containing these species	Associated vegetation zone[b]	Characteristics of species[c]
Open Water / Aquatic				
Chara spp.	1	67		LN
Potamogeton spp. (P. filiformis, P. foliosus, P. pectinatus)	1	67	O	FN
Cladophora spp., Spirogyra spp.	2	100		LN
Potamogeton richardsonii	3	33	O	FN
Myriophyllum exalbescens	4	17	O	FN
Emergent and Marsh / Shore				
Poa spp. (P. pratensis, P. compressa, P. palustris)	1	100	W	GPI, GAI, GPN
Eleocharis palustris	2	100	M	GPN
Phalaris arundinacea	2	50	M	GPN
Hordeum jubatum	3	86	W(D)	GPNΨ
Typha latifolia	4	83	E	FPN
Agropyron repens	5	71	D(W)	GPIΨ
Phleum pratense	6	86		GPI
Agropyron spp. (A. smithii, A. dasystachyum)	7	57		GPN
Cirsium arvense	8	100	W(D)	FPIΨ
Agrostis stolonifera	8	43		GPI
Achillea millefolium		57		FPN
Aster ericoides		57		FPN
Bromus inermis		57		GPI
Grindelia squarrosa		57		FBN
Taraxacum officinale		57		FPI
Scirpus spp. (S. acutus, S. paludosus)		50		GPN

[a] *Occurring in over 50% of this type of wetland. Species with lower occurrence rates are included if they were ranked as a dominant.*

[b] *Species associated with, and at least occasionally dominant in vegetation zones of native wetlands in the grasslands and parklands of western Canada. These zones include:* O = *shallow open water*, E = *emergent deep marsh*, M = *shallow marsh*, W = *wet meadow*, D = *disturbed. (Source: Millar 1976).*

[c] S = *shrub*, F = *forb*, G = *graminoid*, L = *algae*, P = *perennial*, B = *biennial*, A = *annual*, N = *native*, I = *introduced*, Ψ = *in "Weeds of Alberta"*

The two largest ponds in this group, OC21-C02 and C20-C01, had the most prominent band of emergent and shallow marsh vegetation seen at any of the created wetlands. At both, there was an inner band of flooded emergent vegetation including *Typha latifolia* and *Scirpus spp.*, and patches of *Eleocharis palustris*. Surrounding this, was a prominent band of reed canary grass (*Phalaris arundinaceae*), growing in the shallow water along the ponds edge, up to the dryer wetland boundary. OC21-C02 also has a small peninsula of emergent vegetation cover jutting into the central portion at the north end of the pond. Approximately 20% of this ponds area was occupied by emergent species, and approximately 20% was occupied by the band of reed canary grass. At C20-C01, the emergent and shallow marsh species occupied approximately 6% and 24% of the wetland area respectively. The smallest pond adjacent to C32 had peripheral patches of *Typha latifolia, Phalaris arundinacea* and *Eleocharis palustris*. CR25-C02 had remnants of peripheral bands of *Typha latifolia* and *Scirpus sp.* present. CR25-C01 had the least amount of

emergent cover in this group, with only scattered *Typha* plants, *Eleocharis palustris* and possible *Scirpus sp.* Emergent vegetation at these ponds was either browsed or dead as a result of ungulate grazing and muskrat feeding.

The Marsh / Shore zone vegetation was dominated by grasses including *Poa pratensis*, *Hordeum jubatum*, *Agropyron repens*, *Phleum pratense*, *Agropyron spp.*, and *Agrostis stolonifera*. *Cirsium arvense* was the only broadleaf forb listed among the commonly dominant plants at these ponds (Table 8).

3.2.2 Surrounding and upland vegetation and land use

The largest of these wetlands, OC21-C02 is located in a north-south running coulee similar to the type 1 wetlands and as a result, had similar surrounding vegetation including forage grass on the east facing slope, and native grassland on the west facing slope. In contrast, both C20-C01 and the small pond at C32 were surrounded by previously cultivated ground sparsely vegetated by forage species such as *Bromus inermis* and *Medicago sativa*. The majority of this surrounding area at both sites was hayed at the time of survey. The two ponds that did not hold water (C19-C02 and C26-C02) had similar surrounding vegetation to one another. Both had a band of moisture loving vegetation dominated by *Poa pratensis* surrounding the pond and growing in the drainage channel south of the pond. The north west facing slopes at both sites had large eroded weedy patches sparsely vegetated with *Cirsium arvense*, *Poa pratensis* and *Agropyron sp.* including *Agropyron pectiniforme* at C26-C02. The south facing slopes of these ponds consisted mainly of native mixed grassland species. The two remaining ponds, CR25-C01 and CR25-C02 were mostly surrounded by native grassland, except for an eroded south facing slope opposite the dam at both sites. These slopes were predominantly bare, with the sparse vegetation dominated by *Cirsium arvense*, and various other weedy forbs and grasses. The periphery of these ponds, and the drainage coulees into the ponds along the sides of the eroded slope were dominated by *Agropyron repens* and other moisture tolerant grass species.

The approximate percentages of disturbed and undisturbed area within a 300 m radius of the wetlands are shown in Table 9. Two of the sites (CR25-C01, CR25-C02) had more undisturbed land than disturbed. The surrounding land was mostly ungrazed grassland (71 and 56% respectively) with the smaller portion of disturbed land being mostly hayed forage crops. The remaining sites had between 67 and 80% of this surrounding area disturbed. Two sites were predominantly disturbed by grazing (C19-C02, C26-C02), while the remaining sites were dominated by hayed forage crops. The high percentage of grazed land at C19- C02 and C26-C02 resulted from grazing being allowed within the mitigation land base at these sites (grazing leases GR10 and GR8 respectively, APWSS 1995). Haying also occurred within the mitigation land base at two sites: OC21-C02 (haying lease HC3), and C20-C01 (hay permit given to P. Malloff in moist years, APWSS 1995).

Table 9. Estimated % area[a] of upland usage and general vegetation types within a 300 m radius[b] of type 2 wetlands

Land use / vegetation type	Site I.D.						
	C19 - C02	C20 - C01	C26 - C02	C32 "small"	CR25 - C01	CR25 - C02	OC21 - C02
Wetland(s)	1	1		1	1	1	2
Reservoir or river	4		18				
Total % of area covered by water:	5	1	18	1	1	1	2
Treed slope	6		6				
Tall shrubs with forage understory					8	5	
Uncut forage with some low shrubs	9	11	2	27			10
Ungrazed grassland		10		5	74	56	13
Total % of land area undisturbed:	15	21	8	32	82	61	23
Grazed grassland / pasture	36(+44)*	13	32(+22)*				
Hayed forage cropland		59	18	63	16	37	74
Roads		5		4			1
Eroded slope		1	2		1	1	
Total % of land area disturbed:	80	78	74	67	17	38	75

[a] *Based on 1995 (1 : 10,000 scale) air photos.*

[b] *From center of wetland basin.*

* *This amount lies within the mitigation land base boundaries (C19-C02: grazing lease "GR10", C26-C02: "GR8").*

3.2.3 Wildlife use

Aquatic insects and other invertebrates were present at all ponds. Freshwater shrimp were not noted, and snails were only seen at one. Chorus frogs were seen at C20-C01 and CR25-C02. At OC21-C02, a duck and a red-wing blackbird were noted. Swallows were also seen feeding on insects above the pond. At C20-C01, three waterfowl and some songbirds were noted, and possible shorebird tracks were seen on the mud flat by the cattle walkway. When this pond was surveyed for waterfowl in April and May of 1995, two mallards and one golden-eye were sighted (Fyfe 1995). At CR25 C02, a red tail hawk was seen overhead, and a long-beaked wading bird was flushed from the shoreline.

Deer also used these ponds for drinking water and forage as evidenced by tracks, scat, trails, and beds noted at many of these ponds. Deer were seen in the coulee adjacent to CR25-C01. Coyote tracks were seen on the mud flat of two ponds, including C19-C02 which only held a small amount of murky water. Muskrat tracks and feeding damage were present at CR25-C02. Evidence of muskrat feeding was also seen at CR25-C01.

3.2.4 Evaluation of type 2 wetlands

The type 2 wetlands that held water were also similar in percentage of open water and emergent cover to the Shallow Open Water wetland type of Millar (1976). Those that did not hold water did not appear to have the associated vegetation or habitat value of natural seasonal or temporary wetlands.

The average size of this group of ponds is 0.17 ha. This is much less than the 0.4 to 4.0 ha size recommended for wetlands created for waterfowl or other wildlife. Four of these are at or below 0.1 ha, the size range considered to be of little use for wildlife.

OC21-C02 and C20-C01 were the largest of these wetlands (0.30 and 0.29 ha respectively), and had the greatest cover of emergent and shallow marsh vegetation. At the time of the survey, OC21-C02 was already approaching the ideal 50% cover of emergent vegetation preferred by waterfowl. However, this cover was predominantly peripheral, and the tall, and extremely dense nature of this vegetation may have made it slightly less useful to waterfowl than the cover ratio alone suggests. Dabbling ducks have been shown to prefer more broken stands of interspersed cover and open water, or flooded emergent species of a shorter type, and nesting diving ducks have also been shown to prefer more scattered patches of emergents for nesting sites (Kantrud et al. 1989).

In OC21-C02, the mapped bottom contours indicate that at least half of the pond is less than 1.5 m deep, and that it contains some varying bottom contours, allowing for the growth of peripheral, as well as some central patches of emergent vegetation. Because the rest of these ponds were filled or partially filled with water at the time of survey, the depth and bottom contours are not mapped. In ponds where emergent vegetation has developed, the peripheral nature suggest that the ponds are at least 1.5 m or deeper in their center. Over all, the water levels seem lower, and bank slopes appear to be slightly less steep than those seen at the type 1 wetlands, so they may eventually develop more emergent cover. The small size and simple shorelines of these ponds would not likely allow for the irregular bottom contours necessary for an interspersion of vegetation and open water.

The two most frequently dominant submergent species, *Chara spp.* and *Potamogeton pectinatus* are both tolerant of higher concentrations of dissolved salts than many other species (Kantrud et al. 1989). Type 2 wetlands were the only group with *Chara* as the most frequently dominant species (Table 8). *Chara* or "stonewort" has stiff branches due to calcium encrustation, and is most commonly found in slightly hard water (Lamoureux 1970). Small ponds show greater amounts of water loss than ponds with larger surface areas (Millar 1976). It is possible that these small ponds have slightly higher levels of dissolved salts than the larger wetlands.

As in type 1 wetlands, bluegrass is the most frequently dominant non-aquatic species seen. The majority of Emergent and Marsh / Shore zone vegetation colonizing these wetlands are also similar to those seen in the type 1 ponds. In the ponds that contain water, spike rush and reed canary grass are the second most commonly dominant species. Both are shallow marsh species associated with disturbed wetlands. Half of the frequently occurring and dominant Marsh / Shore zone species are either introduced or weedy species. These disturbance species may inhibit the colonization of less aggressive native wet meadow species.

Most of the sites had the majority of their surrounding and upland area under human land use. OC21-C02 and C20-C01, the two largest wetlands with the most emergent vegetation and waterfowl habitat potential had 75% and 78% of the area within a 300 m radius of the wetlands

disturbed by haying, grazing, and roadways. At both of these sites, haying occurred within the habitat mitigation land base up to the windward side of the snow fences. At the two ponds that did not hold water, heavy cattle use was evident within the mitigation land base, increasing weed cover and erosion, and further reducing the value of this land for other wildlife. Two sites (CR25-C01 and CR25-C02), had more than half of their surrounding area as currently ungrazed grassland. Both had limited emergent vegetation cover, and were more like cattle dugouts in appearance than natural wetlands. At CR25-C01, the shallow depth of the pond at the point of the wide cattle walkway allowed cattle access to at least half of the pond. As a result, the water was murky with suspended sediments and algae, and most of the accessible emergents had been browsed.

3.3 Type 3 wetlands: Large irregularly shaped check dam ponds in gently sloping depressions

Five of the check dam ponds were relatively large in size, irregularly shaped, and built in gently sloping depressions. These include: OC05-C01, OC05-C02, OC05-C03, CR25-C04 and CR17-C01.

3.3.1 Wetland vegetation

Open water was the dominant zone in type 3 wetlands. Three ponds had between 76-100% and one had between 51-75% of the wetland area covered by open water (Table 10). At CR17-C01, the drainage outlet was uncapped, so it did not hold the amount of water that it was intended to. Open water covered between 26-50% of this pond. Algae and aquatic vegetation were abundant at type 3 wetlands, with two in the 6-25% cover class, and two in the 26-50% cover class. Aquatic vegetation (besides planktonic algae) was not visible at CR17-C01 (Table 10). Filamentous algae including *Cladophora* and *Spirogyra* was present at all of these wetlands, and was the most commonly dominant vegetation type seen in the Open Water / Aquatic zone. *Myriophyllum exalbescens*, and *Potamogeton spp.* were the next most commonly dominant species, and *Potamogeton richardsonii* and *Chara spp* were also present (Table 11).

Emergent vegetation was very sparse, and fell into the trace to 5% cover class at four of the ponds (Table 10). No true emergent species were noted at CR17-C01. *Typha latifolia* was present at 80%, and *Scirpus spp.* was present at 60% of ponds that held water, but these occurred only as scattered plants in the water or on the recently exposed mud flats (Table 11).

Some shallow marsh species were also present in the shallow water or on the mud flat. *Eleocharis palustris*, *Glyceria striata*, *Glyceria borealis*, and *Beckmannia syzigachne* were listed as commonly dominant at these wetlands (Table 11).

The most abundant species within the wetland area at these sites were agricultural or weedy species found in the shoreline area. The most commonly dominant of these were *Agropyron repens*, *Hordeum jubatum*, *Poa spp*, *Cirsium arvense*, and *Bromus Inermis*. These species were found at all ponds (Table 11). Planted willows were present at least 3 of these ponds.

Table 10. Percent cover[a] of Open Water / Aquatic, Emergent, and Marsh / Shore areas in type 3 wetlands

Site I.D.	Flooded area (ha)	Open Water / Aquatic			Emergent vegetation	Marsh / Shore		
		Total cover	Vegetated	Unvegetated		Total cover	Vegetated	Unvegetated
CR17 - C01	0.63	3	1	3	0	4	4	2
CR25 - C04	0.37	5	2	4	1	2	2	1
OC05 - C01	0.88	5	3	3	1	2	2	1
OC05 - C02	0.57	4	2	3	1	3	3	2
OC05 - C03	0.80	5	3	3	1	2	2	1

[a] *Cover classes based on % cover of total wetland area:*

0 = 0%
1 = trace to 5%
2 = 6 to 25%
3 = 26 to 50%
4 = 51 to 75%
5 = 76 to 100%

Table 11. Dominant and frequently occurring[a] plant species found in type 3 wetlands

Species and designated zone	Order of dominance	% of wetlands containing these species	Associated vegetation zone[b]	Characteristics of species[c]
Open Water / Aquatic				
Cladophora spp., Spirogyra spp.	1	100		LN
Myriophyllum exalbescens	2	80	O	FN
Potamogeton spp. (P. filiformis, P. foliosus, P. pectinatus, P. pusillus, P. zosteriformes)	3	40	O	FN
Potamogeton richardsonii	4	40	O	FN
Chara spp.	5	40		LN
Emergent and Marsh / Shore				
Agropyron repens	1	100	D(W)	GPIΨ
Hordeum jubatum	1	100	W(D)	GPNΨ
Poa spp. (P. pratensis, P. compressa, P. palustris)	2	100	W	GPI, GAI, GPN
Cirsium arvense	3	100	W(D)	FPIΨ
Bromus inermis	4	100		GPI
Eleocharis palustris	5	80	M	GPN
Agrostis stolonifera	6	60		GPI
Glyceria striata	6	60		GPN
Beckmannia syzigachne	7	40	D(M)	GAN
Glyceria borealis	7	40		GPN
Phleum pratense		100		GPI
Rumex triangulivalvis		100		FPN
Crucifer spp.(A. alyssoides, L. densiflorum, C. draba)		80		FAI, FANΨ, FPIΨ
Epilobium ciliatum		80		FPN
Typha latifolia		80	E	FPN
Agropyron spp. (A. trachycaulum &/or A. spicatum)		60		GPN
Bromus commutatus		60		GAI
Cirsium vulgare		60		FBIΨ
Helianthus spp. (H. annuus, H. nuttallii)		60		FAN, FPN
Juncus bufonius		60		GAN
Melilotus officianalis		60		FAI
Ranunculus sceleratus		60		FAN
Salix spp. (S. exigua, S. discolor & others)		60	W	SPN
Scirpus spp. (S. acutus, S. paludosus)		60		GPN
Taraxacum officinale		60		FPI
Thlaspi arvense		60	D(W)	FAIΨ

[a] *Occurring in over 50% of this type of wetland. Species with lower occurrence rates are included if they were ranked as a dominant.*

[b] *Species associated with, and at least occasionally dominant in vegetation zones of native wetlands in the grasslands and parklands of western Canada. These zones include:* O = *shallow open water*, E = *emergent deep marsh*, M = *shallow marsh*, W = *wet meadow*, D = *disturbed. (Source: Millar 1976).*

[c] S = *shrub*, F = *forb*, G = *graminoid*, L = *algae*, P = *perennial*, B = *biennial*, A = *annual*, N = *native*, I = *introduced*, Ψ = *in "Weeds of Alberta"*

3.3.2 Surrounding and upland vegetation and land use

Most of these wetlands offered both native grassland cover and some forage grass cover in the area immediately surrounding the wetlands. Some scattered low stems of rose and western snowberry (buckbrush) were present at all sites but taller, denser patches of shrub cover were rare. One site, OC05-C03 had a sparse shelterbelt of common caragana (*Caragana arborescens*) south of the pond. All of these wetlands had hayed forage cropland very close to the wetland edge, ranging from less than 10 to 50 m away.

The approximate percentages of disturbed and undisturbed surrounding and upland vegetation within a 300 m radius of the pond are shown in Table 12. Four of the sites had between 38% and 47% of the surrounding land disturbed. The majority of this was hayed forage crops, with a smaller amount as grazed grassland and roadways. One site, CR25-C04 had 78% of its land under these human land uses. The undisturbed land in this area consisted predominantly of ungrazed grassland (Table 12).

Table 12. Estimated % area[a] of upland usage and general vegetation types within a 300 m radius[b] of type 3 wetlands

Land use / vegetation type	Site I.D.				
	CR17 - C01	CR25 - C04	OC05 - C01	OC05 - C02	OC05 - C03
Wetland(s)	1	2	4	4	3
Reservoir or river					<1
Total % of area covered by water:	1	2	4	4	3+
Tall shrubs with forage understory					<1
Uncut forage with some low shrubs	21	3	6	8	8
Ungrazed grassland	40	17	43	50	45
Total % of land area undisturbed:	61	20	49	58	53+
Grazed grassland / pasture		30			
Hayed forage cropland	33	45	47	36	40
Roads	3	3		2	3
Eroded slope	2				
Total % of land area disturbed:	38	78	47	38	43

[a] *Based on 1995 (1 : 10,000 scale) air photos.*

[b] *From center of wetland basin.*

3.3.3 Wildlife use

OC05-C01 was noted as having abundant invertebrate life including snails, insects, and freshwater shrimp. The presence of aquatic invertebrates was noted at the remaining wetlands. Boreal chorus frogs were very abundant at the three OC05 wetlands, but were not noted at CR17-C01 and CR25-C04.

At OC05-C01 (the largest pond of the OC05 wetland complex) 15 ducks were counted. Two ducks were seen at OC05-C02. At CR17-C01, 12 ducks took flight from the pond when I arrived, and 5 flew over and landed later on. Four ducks were noted at CR25-C04.

Both wading birds and shore birds were seen at OC05-C01. Two great blue herons were scared from the shallower North end of the pond, and a sand piper was seen on the shore at a later date (See Appendix III). Tracks likely belonging to a blue heron were noted on the mud flat at the adjacent pond (OC05-C02). At OC05-C03, a long beaked shorebird (possibly a curlew) was seen. One shorebird (likely a sand piper) and some songbirds were noted at CR17-C01.

Deer tracks were noted at OC05-C02, and evidence of heavy deer use of the caragana shelterbelt south of the dam was noted at OC05-C03. At CR17-C01, a group of five mule deer (three of them antlered bucks) came down to the pond to drink, and then proceeded in the direction of the reservoir when they sighted me. A muskrat was seen in OC05-C01, and muskrat feeding damage to emergent vegetation was also noted in OC05-C02 and OC05-C03. Muskrat and coyote tracks were also seen at OC05-C03.

3.3.4 Evaluation of type 3 wetlands

Type 3 wetlands were also most similar in open water and emergent cover to Shallow Open Water wetlands described by Millar (1976).

Because they were built in flatter basins, the five larger check dam ponds have relatively gentle bank slopes, and as a result, have a higher potential than the other created ponds of developing a broad expanse of wetland vegetation, and developing vegetation zones similar to those in natural prairie wetlands. At the time of the survey however, emergent and shallow marsh vegetation were both scarce, and the shorelines were relatively bare and colonized mainly by disturbance species. Although muskrat feeding may be partly responsible for the limited amount of emergents, it is suspected that the development of wetland vegetation may also be limited by hydrological factors.[1] In order to increase their likelihood of success, hydrologic characteristics of created wetland projects should mimic the hydrology of local natural wetlands (Kentula et al. 1992). However, hydrology is often not considered in planning created wetlands, and as a result, most are unlikely to develop or function as do natural wetlands (Kentula et al. 1992).

The average size of type 3 wetlands is 0.72 ha, within the suggested size range for constructed wetlands and the optimum size range for waterfowl use. The lack of tall dense emergent vegetation, and the presence of large mud flats and shallow water near the shore provided ideal feeding areas for shorebirds, wading birds, and waterfowl. However, the limited emergent cover makes these ponds currently unsuitable for nesting of diving ducks, grebes, red-wing blackbirds, and other overwater nesting birds. This may also result in lower waterfowl breeding pair densities, as there is currently not enough cover to visually separate territorial males (Green et al. 1986)

The proximity of the four relatively large sized OC05 wetlands to one another, and the shallow water and abundant aquatic vegetation and invertebrates present at most of these wetlands make them potentially useful for the purpose of waterfowl feeding and brood rearing. The surrounding

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[1] See Eldrige 1990, and Van Der Valk 1989 for an overview of the ecology and vegetation dynamics of northern prairie wetlands, and Shay and Shay 1986, Neil 1993, and Millar 1972 for ecology of specific emergent species in natural Canadian prairie wetlands.

land around these ponds contained both shorter native grassland suitable for some upland nesting ducks and shorebirds, as well as forage species of suitable height to provide nesting cover for most dabbling ducks. However, current lack of emergent vegetation necessary for visual isolation of breeding pairs, and hiding cover for both adults and young may reduce both the potential number of breeding pairs able to use these ponds, and limit nesting success of those that do. As well, dense patches of shrub cover and other obstacles to predator vision or movement was limited at all of these ponds. Haying of adjacent upland at all of these ponds may also reduce potential dabbling duck nesting success.

The three OC05 wetlands in this group originally had nesting boxes placed on poles to encourage wood duck nesting. All three had fallen down and were lying in the water at the time of survey.

Tall shrubs used by deer for browse and cover were lacking at all but one of these projects. One previously planted shelterbelt of *Caragana arborescens,* a thorny introduced shrub, was present behind OC05-C03. Well worn trails, numerous bedding down sites, and browsing damage within the shelterbelt indicated heavy deer use, and suggests that more shrub cover is currently needed in this area. Unfortunately, more palatable native tree and shrub seedlings planted near the ponds for this purpose were mostly overgrown by weeds and forage species, and browsed down by deer. CR25-C04 was developing a marshy area on the north west end of the pond, but also currently lacked emergent vegetation and appeared to be quite deep over much of its area. Most of its surrounding land (78%) was currently grazed pasture and forage cropland.

CR17-C01 held only a small portion of the water it was intended to hold, but provided habitat values similar to those noted for the OC05 wetlands. Despite its low water levels, murky water, and lack of visible aquatic or emergent vegetation, incidental wildlife observations were higher here than at most ponds in the survey. Its proximity to the reservoir may make this pond particularly useful for staging waterfowl. Capping of the drainage pipe below the dam (which has likely already taken place) will result in more aquatic vegetation development, but possibly less value to shore birds which currently feed in the shallow water and broad mud flats. However, the gently sloped shoreline contours on the as-built site map indicate that if this wetland is inundated to FSL, the entire wetland area will still be less than 1.5 m deep, a level appropriate for both aquatic and emergent vegetation growth useful to both wading birds and waterfowl. If the drainage pipe is capped, this pond should be monitored carefully for changes in vegetation growth and wildlife use. Haying of forage grass which currently occurs within the protected wetland area only a few meters above the north shore of the wetland, is potentially destructive to bird and small mammal habitat, and conflicts with its intended wildlife habitat use. Haying within these boundaries should not be allowed in the future.

3.4 Riparian dike wetland projects

Ten riparian dikes and terraces were also constructed within the upper flood zone of the reservoir. These structures were built to create new riparian habitat by flooding areas adjacent to the reservoir with 0.5 to 1.5 meters of water for a 2 to 4 week period each spring. Two riparian dikes that were assessed were ON04-C01 and ON04-C02. Although these assessments were done in the fall when these areas are expected to be dry, previous dam assessment records indicate that ON04-C01 and ON04-C02 do not hold water for the intended period of time in the spring.

3.4.1 Wetland vegetation

The dike berm at ON04-C01 was dominated by forage species and weeds including Kentucky bluegrass, awnless brome, quack grass, alfalfa, sweet clover, and Canada thistle. The same species (except for sweet clover) dominated the intended wetland area behind (east of) the dike, and the flat area in front of the dike. Here, quack grass and alfalfa were most abundant. Most of this bottomland area in front of and behind the dike berm was hayed at the time of the survey. A narrow strip of land immediately in front (west) of the dike containing the overgrown mitigation shrub plantings was spared from haying by the row of snow fences that border them. A steep sided eroded depression in the wetland area behind the dike was also spared likely because the slopes were too steep for the haying machinery to proceed.

The vegetation covering the dike berm and islands at ON04-C02 was generally the same mix of weeds and forage species as that seen at ON04-C01. Scattered buckbrush was also present on the dike berm at ON04-C02, and a prominent patch of this shrub was also present in front of (east of) the dike berm before the reservoir mud flat at this site. The intended wetland basin behind the dike was dominated mostly by native tussock grasses including green needle grass *(Stipa comata)*, Kentucky bluegrass, bluebunch wheat grass *(Agropyron spicatum)*, and rough fescue *(Festuca campestris)*.

3.4.2 Surrounding and upland vegetation and land use

At ON04-C01, forage species had spread to the lower slope and NW facing coulees behind the forage dominated project site. Native sloped grassland and upland grassland vegetation was present on the mid to upper slopes. Scattered buck brush occurred on the slopes behind the ON04-C01 project area, and taller buck brush and other shrubs including Amelanchier alnifolia and Potentilla fruticosa were growing in the NW facing side of coulees.

At ON04-C02, the north east facing slopes and the tree and shrub seedlings planted there were dominated by a dense carpet of *Bromus inermis*, black medic (*Medicago lupulina)* and *Poa pratensis*. The upland consisted of pasture containing some native grasses including *Stipa viridula* and *Agropyron smithii* and *Poa pratensis*, as well as large patches of crested wheat grass (*Agropyron pectiniforme*).

The approximate percentages of disturbed and undisturbed surrounding and upland vegetation within a 300 m radius of the center of the wetland area are shown in Table 13. ON04-C01 had 30% of this area covered by water (the reservoir) and the majority of the land area (51%) was currently undisturbed. Most of this is ungrazed grassland with some uncut forage and the occasional patch of taller shrub. The remaining amount was covered by forage cropland, and grazed pasture. ON04-C02 has less of this area covered by water (16%), and more undisturbed land (70%). This included uncut forage on the slope behind the dams, as well as some remnant Douglas fir stands along the slopes bordering the reservoir. The disturbed land at this site consisted of the barren shoreline caused by lowering water levels in the reservoir.

Table 13. Estimated % area[a] of upland usage and general vegetation types within a 300 m radius[b] of riparian dike wetlands

Land use / vegetation type	Site I.D.	
	ON04 - C01	ON04 - C02
Wetland area	0	0
Reservoir or river	30	16
Total % of area covered by water:	30	16
Treed slope		30
Tall shrubs with forage understory	4	
Uncut forage with some low shrubs	13	40
Ungrazed grassland	34	
Total % of land area undisturbed:	51	70
Grazed grassland / pasture	3	
Hayed forage cropland	16	
Bare shore line		14
Total % of land area disturbed:	19	14

[a] *Based on 1995 (1 : 10,000 scale) air photos.*

[b] *From center of wetland basin.*

3.4.3 Wildlife use

At ON04-C01, a group of ten mule deer were seen leaving the project area and heading up a coulee behind the site. Coyote tracks and numerous pocket gopher mounds in the uplands were also seen. At ON04-C02, deer tracks were present and a mule deer was seen resting in the shrubs. Numerous deer tracks were seen on the mudflat below the treed slope.

3.4.4 Evaluation of riparian dike wetland projects

In order to replace some of the bottom-land habitats lost to flooding, riparian vegetation including emergent, shallow marsh and wet meadow plants, willows, and narrow leaf cottonwood were planted below or at FSL. Riparian shrubs were planted above FSL. Due to the inability of these structures to hold water for the intended period of time in the spring, riparian trees and natural sedge meadows (the intended vegetation) were not noted at the time of assessment. Seepage due to silt, sand and gravel substrates beneath the wetland area was likely the cause of this water loss (Nilson, pers. comm. 1995). As well, most of the remaining riparian dike wetlands (at least 6 out of 8 and possibly more) do not hold water and subsequently are not developing riparian wetland and bottomland tree and shrub vegetation as intended (Nilson, pers. comm. 1995).

Wildlife habitat mitigation shrub plantings present at these sites were overgrown by surrounding site vegetation. However, the dense grass/legume mixture itself currently provides a source of food and spring and summer cover for deer, songbirds and small mammals. If these wetlands had held

water, the vegetation on the islands would have also provided suitable nesting cover for geese and dabbling ducks (Duebbert 1982). Haying occurred within the mitigation project area at ON04-C01 (haying lease HC8, APWSS 1995). This conflicts with the intended use of this land for wildlife habitat, and should not be allowed in the future.

3.5 Evaluation of commonly dominant vegetation species for all wetlands surveyed

Some wildlife habitat values of the most frequently dominant aquatic plant species found in all wetlands surveyed are listed in Table 14a.

Table14a. Habitat value of most frequently dominant aquatic plant species found in all wetlands surveyed. Species are listed in descending order of dominance.

Scientific name	Common name	Wildlife habitat value
Potamogeton spp. *	Various (thin leaved) pondweeds	*P. pectinatus* is probably the most important waterfowl food on the prairies, tubers seeds and leaves are eaten by waterfowl (Caldwell 1960, Lamoreaux 1970).
		P. pectinatus is important as an oxygenator, and is eaten by birds and aquatic oriented mammals (Burland 1989).
		Seeds and tubers of *P. filiformis*, and seeds of *P. foliosus*, *P. pusillus* and *P. zosteriformis* are important duck food where they are abundant (Caldwell 1960)
Cladophora spp., *Spirogyra spp.*	Filamentous algae	Eaten by invertebrates (Murkin 1989). Vertebrate feeding on algae has not been documented in any detail, however American coots, gadwalls, and mallards have been observed feeding on mats of filamentous algae by Murkin (1989).
		Grazing by tadpoles (Rana aurora) was noted to reduce densities of filamentous green algae on a lake in British Columbia (Dickman 1968).
		Drowning or suffocation after becoming entangled in mats of filamentous algae was one of the chief causes of death among scaup ducklings in British Columbia (Munro 1941).
Potamogeton richardsonii	Clasping-leaf pondweed	One of the more valuable pondweeds, as seeds rootstocks, and parts of stem and leaves are eaten by waterfowl (Caldwell 1960).
		Provides good habitat for aquatic organisms, all or part of plant eaten by ducks, shorebirds, muskrat, beaver and moose (Burland 1989).
Myriophyllum exalbescens	Northern watermilfoil	Provides habitat for aquatic invertebrates. Important as food for muskrat, moose and waterfowl. (Burland 1989).
		Seeds and leaves consumed by waterfowl (Caldwell 1960).
Chara spp.	Macrophytic Algae, Stonewort	Provides excellent habitat for aquatic invertebrates such as freshwater shrimp (Allan et al. 1989).
		Occasionally eaten by bluebirds, tubers occasionally eaten by ducks (Lamoreux 1970).

* Includes: *P. Pectinatus* (Sago pondweed), *P. filiformis* (Thread-leaved pondweed), *P. foliosus* (Leafy pondweed), *P. pusillus* (Small-leaf pondweed), and *P. zosteriformis* (flat-stemmed pond weed).

Phytoplanktonic or microscopic algae were present in all ponds but were not sampled or identified in this survey. In one pond with unlimited cattle access (C19-C01), high concentrations of

suspended single celled algae imparted a green color and a fowl odor to the water. Filamentous algae was not microscopically identified. Identification of dominant types was based on physical traits including color and texture (see Allan et al. 1989). Algae likely of the genus *Cladophora* was found to be most abundant, with the occasional appearance of *Spirogyra spp.*, and more rarely *Pithophora spp.* During sunny hot weather, filamentous algae growing on the pond bottom may float to the surface, forming a scummy, bubble filled mat (Burland 1989). These surface mats increase water temperature and evapotransporation, and reduce oxygen levels when they decompose (Allan et al. 1989). Although filamentous algae did not appear to be overly abundant at most wetlands, at some of the larger shallower wetlands, particularly OC05 -C03, it covered a large portion of the ponds surface area. This may reduce the potential of these ponds for waterfowl brood rearing, as broods quickly abandon ponds where heavy scum of *Cladophora* exist (Keith 1961).

Chara, a macrophytic algae usually found in hard water, alkaline lakes or slow moving calcium rich streams (Burland 1989), was also commonly seen on the bottom of these ponds.

All of the aquatic macrophytes dominant in these wetlands provide excellent habitat for aquatic invertebrates. Each of these species have highly dissected leaves which tend to support greater invertebrate assemblages than do plants with more simple leaf structure (Fredrickson and Reid 1988). Although no invertebrate sampling took place, a relatively diverse fauna appeared to be present among the submergent vegetation at these sites. The achenes and vegetative parts of all of these submergent aquatic species are also considered to be valuable or very important foods of both waterfowl and muskrats.

The frequently dominant non-aquatic vegetation in these wetlands are listed in Table 14b. These included a mix of Emergent, Shallow Marsh, Wet Meadow, and Disturbance vegetation zone plant species growing on the periphery of the central Open Water zone. *Typha latifolia* was the only frequently dominant emergent species, although patches of bulrush (*Scirpus acutus* and *S. paludosus*) were occasionally present in deeper water.

Eleocharis palustris, Phalaris arundinacea, Beckmannia syzigachne, Carex spp., and *Glyceria grandis* were also frequently dominant species in the created wetlands. These are all native species that are commonly found in the Shallow Marsh zones of natural wetlands. According to Achuff et al. (1988), the most common wetland type of the northern fescue grassland are wet marshes characterized by members of the knotweed family (*Polygonum spp.*), creeping spike rush (*Eleocharis palustris*), and awned sedge (*Carex atherodes*). The shallow marsh areas seen in the created wetlands were in most cases limited to a narrow band of shallow water along the ponds periphery. Creeping spike rush was common in the shallow water and shoreline of almost all of these wetlands. Awned sedge was not noted, but may have been present. Other similar species of tall shallow marsh sedges including *Carex aquatilis, Carex rostrata (C urticulata)* and *Carex lanuginosa* were seen, but were usually more abundant in the marshy drainage channels behind the dams than in the periphery of the ponds themselves. Water smartweed *(Polygonum coccineum)* was only seen at one wetland.

Epilobium ciliatum is a species of natural Wet Meadow zones, and was very common on the exposed mudflats of most ponds. *Agropyron smithii* is a native prairie grass species common in the surrounding grassland vegetation. It tolerates flooding, saline conditions, and moderate drought (Hardy BBT 1989).

Table14b. Habitat value of most frequently dominant plant species found in the Emergent and Marsh / Shore zone of all wetlands surveyed. Species are listed in descending order of dominance.

Scientific name	Common name	Wildlife habitat value
Poa spp.[a]	Bluegrass	*P. pratensis* is rated as having a high forage value for small mammals, and receives high forage use by mule deer and elk (Hardy BBT 1989)
		Blue wing teal have been reported to nest in bluegrass (Liveszy 1981).
Hordeum jubatum	Foxtail barley	Provides good forage and cover for small mammal, good forage for mule deer, and fair forage and cover for game birds (Hardy BBT 1989).
Agropyron repens	Quack grass	Grass can be used by dabbling ducks for nesting cover (Liveszy 1981)
Eleocharis palustris	Spike rush	Seeds, rootstocks and tubers are fairly important waterfowl food. Stems provide good brood cover (Caldwell 1960).
Typha latifolia	Common cattail	Plants provide excellent bird and small mammal habitat. Red-winged blackbirds use plants for perching and nesting. Upland game birds including grouse and pheasants use dried cattail for winter cover (Burland 1989).
		Cattails provide excellent waterfowl cover and duck nesting cover, especially when interspersed with other plants and open water (Townsend 1965).
		Geese eat starchy rootstocks, and stem and leaves are used to build nesting platforms (Caldwell 1960).
		Muskrats eat rootstocks and use plant material to build lodges (Weller 1981). Terrestrial mammals may also eat aerial portions (Burland 1989).
Phalaris arundinacea	Reed canary grass	Well interspersed, flooded stands used by waterfowl, unflooded stands used by ducks for nesting cover (Ducks Unlimited staff pers. comm. in Haworth-Brockman and Rushforth Guinn 1987).
		Plants provide cover for red-winged blackbirds and other songbirds (Joyner 1978).
		Good cover value and fair forage value for mule deer, game birds and small mammals, seeds are favored by meadow voles (Hardy BBT 1989).
Phleum pratense	Timothy	Eaten by mule deer (Sheppard 1960). A preferred forage grass of elk (Stelfox 1980). Seeds eaten by birds (Hardy BBT 1989).
Agrostis stolonifera	Redtop	Not as palatable as other wetland species. Seeds, cover and herbage useful to some wildlife species (Hardy BBT 1989)
Bromus inermis	Awnless brome	Eaten by mule deer (Hungerford 1970). A preferred forage grass of elk (Stelfox 1980)
		Used as nesting cover by dabbling ducks (Liveszy 1981).
Beckmannia syzigachne	Slough grass	Seeds occasionally eaten by ducks (Caldwell 1960)
Cirsium arvense	Canada thistle	Frequently eaten fall and early winter food of mule deer in Waterton lakes National Park (Bouckhout 1972).
		Provide nesting cover for dabbling ducks (Keith 1961).
Carex spp.[b]	Sedges	Seeds consumed by waterfowl (Caldwell 1960).
Epilobium ciliatum	Northern willow-herb	Other species of *Epilobium* noted as being good forage for mule deer (Hardy BBT 1989).
Agropyron spp.[c]	Wheat grasses	A preferred forage grass of elk (Stelfox 1980).
Glyceria grandis	Tall manna grass	Provides excellent cover for waterfowl, seeds eaten by geese, nutritious seeds and grass eaten by many forms of wildlife (Johnson et al. 1995)

[a] Includes: *P. pratensis* (Kentucky bluegrass), *P. compressa* (Canada bluegrass), *P. palustris* (Fowl bluegrass).
[b] Includes: *C. aquatilis* (Water sedge), *C. lasiocarpa* (Woolly sedge), and *C. rostrata* (Beaked sedge).
[c] Includes: *A. smithii* (Western wheat grass), and *A. dasystachyum* (Northern wheat grass).

The three most frequently dominant species overall were *Poa spp.*, *Hordeum jubatum*, and *Agropyron repens*. While *Poa* is a regular component of natural Wet Meadow zones, and is generally considered to be a desirable species, the native *Hordeum jubatum* and introduced *Agropyron repens* are common to disturbed wetlands, and listed as problem cropland weeds in Alberta. *Hordeum jubatum* is a prolific seed producer, and an aggressive pioneer on disturbed sites. It is also tolerant of a wide range of moisture conditions and soil salinity (Hardy BBT 1989). Agropyron repens spreads rapidly by means of abundant seeds and rhizomes, and is extremely difficult to control once established (Stearman 1983). The remaining frequently dominant species include moisture loving agricultural forage grasses (*Phleum pratense, Bromus inermis*), and introduced weeds and grasses common to moist disturbed areas (*Cirsium arvense, Agrostis stolonifera*). All of these species are currently providing stabilizing cover on the relatively bare shorelines of these ponds.

In native wetlands, the Disturbed wetland vegetation zone is considered to be transitory, and once the repeated exposure of the soil ends, it is normally transformed into one or more of the stable vegetation zones (Millar 1976). During this transitional period, a few pioneering species may continue to dominate for a long time as part of the stabilizing vegetation (Millar 1976). The hydrological regimes of these created wetlands are currently unknown, so it is difficult to predict when (or if) stable wetland vegetation zones will eventually develop. It is possible that *Hordeum jubatum* and *Agropyron repens* may persist for some time, out-competing other less aggressive native species.

The two main vegetation types present in the land immediately surrounding the wetland area were uncultivated grassland and stands of weedy or agricultural forage species. Both vegetation types are potentially useful to nesting wetland associated birds, however preferred nesting cover differs between species. Nesting shorebirds avoid tilled fields, and prefer native grassland to planted grass (Eldrige 1992). Upland nesting waterfowl species, particularly dabbling ducks, can utilize both native prairie cover and seeded cover consisting of introduced or native species. Blue-winged teal prefer nesting in unplowed prairie, but also have been known to nest in seeded bluegrass (Klett et al. 1984). Northern pintail prefer sparser mixed grass prairie vegetation (Duncan 1986), while mallards and gadwalls were noted to prefer nesting in dense seeded introduced or native grasses and legumes over unplowed prairie grassland (Klett et al. 1984).

Un-mown hayfields including tall grasses such as quack grass, awnless brome and timothy, and legumes such as alfalfa and sweet clover generally provide suitable nesting cover for upland nesting ducks (Livezey 1981). This mixture of tall grass and legumes was often seen on the east facing slopes at many sites. At several sites, this vegetation was extremely tall and dense, and consisted almost entirely of awnless brome, or quack grass. In general, heterogeneous cover is more productive for nesting than monotypic stands (Klett et al. 1984, Duncan 1986). Although scattered rose and buckbrush were present in the peripheral vegetation at almost all sites, dense patches of shrubs were not common. Dense shrub cover including western snowberry (*Symphoricarpos occidentalis)* and woods rose (*Rosa woodsii*) have been noted as a preferred nesting cover for island nesting mallards and gadwalls (Duebbert et al. 1983). Patches of dense shrub cover offer good nest concealment and may also provide a barrier to predator animal movement.

The surrounding area and uplands that were not currently grazed, hayed, or previously cultivated were called "native grassland" in this survey. Although the Oldman River Dam area occurs predominantly in the fescue grass ecoregion (Strong and Leggat 1992), the native "*Festuca*

scabrella association" dominated by rough fescue (*Festuca scabrella*), and Parry's Oat grass (*Danthonia parryi*), currently exists only as rare relict areas (Moss and Campbell 1947). Most of this grassland has been broken for agriculture, and the majority of remaining unbroken areas have been altered greatly in species composition through grazing and mowing (Moss and Campbell 1947). The majority of grassland area in the vicinity of the Oldman River Dam is dominated by western wheat grass (*Agropyron smithii*), June grass (*Koeleria macrantha*) and needle and thread grass (*Stipa comata*) (Hardy Associates 1986). Green needle grass (*Stipa viridula*) is also common.

Native grassland areas are extremely important to grassland associated birds and other prairie wildlife species, many of which are currently rare or endangered in Alberta. Plant species composition has been found to be more important than plant structure in determining habitat associations of grassland bird communities (Rotenberry 1985). While the replacement of one key plant species by another may preserve the structural configuration of a particular ecosystem, substantial changes in bird communities could result (Rotenberry 1985). Although dense, seeded non-native forage cover is readily used by nesting waterfowl, stands of native grasses may be sufficiently productive for duck nesting (Livizey 1981) and may be beneficial for a wider range of species.

3.6 Comments on some photographed wetlands not included in the field survey

Aerial photographs of several of the riparian dike wetlands not assessed in the field survey, (C20-W01, ON23-W01, CR13-W01, C32-W01) confirmed previous reports that these dikes were not functioning as intended (Nilson, pers. comm. 1995). These projects appeared to have similar vegetation to that seen at ON04-C01 and ON04-C02. One riparian dike project (ON02-W01) held water at the time of the photograph (September 9 1995), and was functioning as a riparian check dam pond rather than a seasonally flooded riparian habitat (Appendix III).

The OS17 complex of wetlands includes 2 "enhanced" natural wetlands (OS17-C01, and OS17-C03) that are filled with water from the reservoir by means of an electric pump. Supplemental water supplies were to be provided to these wetlands to stabilize and maintain water levels until planted tree and shrub cover in the vicinity were well established (Green and Eccles 1989). The September 9th photographs showed both wetlands having a central open water portion with algae and submergent vegetation, and an abundance of peripheral emergent vegetation and willows surrounding the open water. Existing shelterbelts are present in the vicinity of these ponds. OS17-C01 has a shallowly flooded area adjacent (west) of the pond, and a central island built for geese. Three nesting pairs of Canada geese, and a wide variety of waterfowl including various species of dabbling ducks, diving ducks, coots, and grebes were noted at this pond during visits between April and June of 1995 (Fyfe 1995). Although the permanent water is attractive to waterfowl, continuous high and stable water levels may eventually kill off the emergent plants, which require seasonal fluctuations and suitable drawdown periods in order to reproduce (Eldrige 1990). If these wetlands are to be supplemented with water in the future, flooding and drawdowns that duplicate the water dynamics of a natural prairie wetland should be followed (Eldrige 1990). It may also be beneficial to allow these wetlands to revert back to their natural water regimes. Seasonal and temporary wetlands are some of the most productive and important wetland types for waterfowl and wildlife, but this type of wetland is not represented by the created wetland projects, which are all relatively permanent shallow open water ponds. Despite the attractiveness of these semi-natural wetlands to waterfowl, haying occurs in the immediate vicinity of both OS17-C01 and OS17-C03.

If possible, haying of this area should be discontinued, or at least deferred until well after the critical brood rearing period. Both the dugout (OS17-C02) and the check dam pond (OS-C04) at this project area appear to be highly productive. Haying occurs in the periphery of these as well.

OS40-C01 is a large, shallow, roughly circular shaped wetland with a central waterfowl island connected to the shore by a bridge of land. This island would provide loafing areas for waterfowl, but would provide little protection from predators if used for nesting. Numerous species of both dabbling and diving ducks were noted to use this pond between April and June of 1995 (Fyfe 1995). This pond appears to have very little emergent or shore vegetation, and would likely provide similar habitat for waterfowl and shorebirds as seen in the type 3 wetlands (particularly the OC05 complex) assessed in this survey.

Two of the riparian dams not assessed in this survey (OC22-W01 and OS50-W01) were larger, and more irregularly shaped than those included in the type 1 wetlands. The remaining riparian check dam ponds were relatively narrow and dart shaped, with very little (if any) peripheral emergent vegetation. The aerial photograph of one riparian check dam pond, OS52-W01, shows extensive algae growth throughout the pond, and brown murky water in the vicinity of the cattle walkway.

4. SUMMARY AND CONCLUSIONS

4.1 Suitability of physical characteristics of the wetland projects for vegetation colonization and wildlife use

4.1.1 Wetland type

All of the wetlands that held water were most similar in open water and emergent vegetation cover to the Shallow Open Water wetland type described by Millar (1976). Shallow Open Water wetlands (also known as ponds) generally have lower bird species richness and abundance, and fewer muskrats than wetland types with a higher percent cover of emergents interspersed with patches of open water (Weller 1981). These created wetlands may also be of a type not typical of the natural wetlands of the region. According to Achuff et al. (1988) in the northern fescue grassland region, wet marshes (likely Shallow Marsh wetlands of Millar 1976) are most common, and wet meadows and deep marshes (likely Emergent Deep Marsh, and Shallow Open Water wetlands of Millar 1976) are generally not common (Achuff et al. 1988). It is unlikely that created ponds can replace the lost functions and values of natural wetlands that are drained or filled (Owen 1990).

4.1.2 Size

Out of 23 wetlands with flooded area provided on the site maps, the majority of these (19) were smaller than the recommended size for wildlife habitat (0.4 to 4 ha) and the optimum size for waterfowl use (0.4 to 2 ha). Five of these (three type 2, and two type 1 wetlands) were at or below 0.1 ha, a size considered to be of little use to wildlife (Green et al. 1986). The four sites within the recommended size range were type 3 wetlands. One of these (CR17-C01) did not hold the intended amount of water due to an uncapped drainage pipe.

4.1.3 Depth, bank slopes and bottom contours

Type 1 wetlands were generally built in steep sided coulees, appeared to be relatively deep centered and have sufficiently steep bank slopes to limit emergent vegetation to a peripheral band. The narrow shape of these wetlands does not allow for a diversity of bottom contours that would encourage an interspersion of emergent vegetation and open water. Most type 2 wetlands, and all type 3 wetlands were built in wider shallower basins, and subsequently had gentler bank slopes and a higher proportion of shallow water and mudflats. A few of these wetlands also had bottom contours that would allow vegetation development in more central regions of the wetland.

4.1.4 Shoreline configuration

Although some type 3 wetlands were slightly irregular in shape, most of the wetlands assessed had relatively straight, simple shorelines. Simple shorelines do not offer the same protection from wind and wave erosion, or provide the increased edge, habitat diversity and wildlife production values associated with convoluted shorelines (Green et al. 1986).

4.1.5 Substrate

The majority (22 out of 25) of the check dam wetlands assessed in this study held water. The two riparian dike wetlands assessed in this survey (and at least 6 of the remaining 8 riparian dike projects) did not hold water for the intended period of time in the spring. Seepage occurred as a result of silt, sand, and gravel substrates present below these projects (Nilson, pers. comm. 1995).

4.1.6 Hydrology

Although hydrology was not assessed in this survey, it is suspected that hydrological factors may be limiting wetland vegetation development at these habitat projects. A study comparing created wetlands to natural wetlands in Oregon and Connecticut showed that created wetlands had greater percentages of their surface area as open water, greater mean water depths, and significantly less monthly water fluctuations than did natural wetlands (Confer 1990). It is possible that similar differences exist between the created wetland projects on the Old Man River Dam mitigation land base and existing native wetlands of the area. All of the created wetland projects that held water had the majority of their wetland area as open water. The majority of these wetlands were deep centered (over 1.5 m) and steep bank slopes often limited shallower areas suitable for emergent growth to narrow peripheral bands. Although seasonal water fluctuations were not measured, the fact that most of the wetlands were almost at FSL, or only slightly below FSL in September and early October suggest that water levels at these ponds (at least in very moist years) do not fluctuate very much throughout the season.

4.2 Vegetation development

The Open Water / Aquatic vegetation zone was the most prominent zone at all of the wetlands that held water. A variety of beneficial submergent aquatic species providing both habitat for aquatic invertebrates, and food for waterfowl and muskrats were found in almost all of these. Commonly noted submergent macrophytes include *Potamogeton pectinatus*, *Myriophyllum exalbescens*, and *Potamogeton richardsonii*. Filamentous algae and macrophytic branching algae (*Chara spp.*) were also very common.

Emergent vegetation including *Typha latifolia* and *Scirpus spp.* also occurred at most wetlands, but usually only in small amounts. Both topographic and hydrological limitations, as well as muskrat feeding may have been limiting emergent growth at many of these wetland projects.

Distinct Shallow Marsh and Wet Meadow vegetation zones seen in natural prairie wetlands had not yet developed. Instead, the combined Marsh / Shore zone of these wetlands contained some typical Shallow Marsh and Wet Meadow species, but were generally dominated by vegetation common to disturbed wetlands, including invasive moisture loving species such as *Poa pratensis* and *Hordeum jubatum*, and introduced agricultural or weedy species such as *Agropyron repens*, *Phleum pratense* and *Bromus inermis*.

Because the terraces and dikes constructed within the upper flood zone of the reservoir did not function as intended, new riparian habitat (including riparian shrubs, sedge meadows, and bottomland tree and shrub habitat) had not developed in these projects as planned (Nilson and Green 1989).

4.3 Surrounding and upland vegetation and land use

The vegetation surrounding the wetland usually contained some portion of native grassland and some tall, dense uncut forage species. Some natural regeneration of rose and buckbrush was occurring in the vicinity of these sites. Only a few of the wetland projects had patches of taller shrubs.

The amount of protected area around almost all of the created wetlands was less than optimal, and on average, approximately half of the surrounding upland area within a 300 m radius of the wetlands was under some form of human land use. Most of this was hayed forage cropland, but grazed grassland was also prominent. Both of these uses reduce the habitat value of this land for upland nesting birds. Most of the undisturbed land in this area was ungrazed grassland.

Grazing occurred within the mitigation land base at 4 sites (OC26-C02, C19-C01, C19-C02, C26-C02), and haying occurred within the land base at 5 sites (CR17-C01, C20-C01, ON04-C01, OC21-C01, OC21-C02).

4.4 Wildlife habitat value

Wetlands that held water were used by aquatic and wetland associated wildlife including invertebrates, frogs, shorebirds, wading birds, waterfowl and muskrats. Deer, coyotes, raptors, song birds, rodents and other terrestrial wildlife also used these wetlands as source of drinking water, food and / or cover. Whether they held the intended amount of water or not, all of the created wetlands were found to contribute some additional wildlife habitat value to the mitigation land base.

Type 1 wetlands currently provide some suitable muskrat habitat, and these small, relatively isolated ponds may also be used for waterfowl pairing. Due to physical limitations however, this type of wetland is generally less suitable for amphibians, shorebirds, wading birds, and waterfowl production than the larger, shallower type 3 wetlands. Type 3 wetlands are more likely to eventually develop the vegetation zones and the wildlife habitat values associated with shallower native prairie wetlands. The small size of most type 2 wetlands may limit their usefulness to waterfowl and other wildlife, and increase their chances of drying up under less favorable moisture conditions.

4.5 Status of wildlife habitat enhancement measures in the vicinity of wetland projects

At the time of the assessment, many of the wildlife habitat enhancement measures in the vicinity of these ponds were not functioning as intended.

Five out of the six wood duck nesting boxes placed on poles at these sites had fallen into the water.

Willow planted along the shoreline had survived at 52% of the ponds in this survey. However, no stands or patches of willow had developed. Only a few stems, usually less than 1m tall were seen at each of these sites.

The mitigation tree and shrub plantings in the vicinity of the wetlands showed very low survival and growth largely as a result of deer browsing damage and competition with weedy forage species present at these sites (Pichlyk 1996). Snow fences erected to increase moisture for the shrubs planted below them tended to encourage the growth of invasive moisture loving grass species such as awnless brome and quack grass. These often formed dense monotypic stands which out-competed the mitigation plantings as well as other native vegetation at the sites.

5. RECOMMENDATIONS

5.1 Monitoring of wetland creation projects

5.1.1 Assessments and monitoring of wetland vegetation

For future wetland vegetation assessments, a more quantitative approach using transects and appropriate sized quadrats to measure density or coverage should be used (see Eccles et al. 1988). Once a suitable sampling method is established, it should remain constant over time and consistent among sites to facilitate evaluation of vegetation development both within and between wetlands (Kentula et al. 1992). Submergent aquatic vegetation should also be scientifically sampled along transects crossing the wetland basin to obtain a more quantitative description of the species composition and abundance (see Eccles et al. 1988 for some suggested field methods).

A survey of the vegetation communities present at natural wetlands of this area is recommended to provide a reference or benchmark for assessing the vegetation development seen at the created wetland projects. A quantitative comparison of the plant communities found in natural and created wetlands may identify any significant differences in species composition, abundance or diversity, and may indicate where corrective measures may be necessary.

5.1.2 Monitoring of seasonal hydrology of selected wetland projects and natural wetlands of the area

Hydrological characteristics of created wetland projects should mimic the hydrology of local natural wetlands in order to increase their likelihood of success(Kentula et al. 1992). In order to determine whether hydrological factors including hydroperiod, water depths, and frequency of water level fluctuations, are currently limiting the vegetation growth and habitat potential of these created wetlands, a better understanding of both the hydrology of the created wetlands and the hydrology of the natural wetland that we are trying to imitate is currently required.

Hydroperiod, flooding frequency and duration, and water depths can be determined from water level data (Mitch and Gosselink 1986). Water level data can be recorded continuously using a water level recorder, or by reading a staff gauge during periodic site visits (Kentula et al. 1992). It is recommended that permanent staff gauges be placed at both the selected wetland projects and at selected natural wetlands in the area, and that water levels be measured at both throughout the year. Green et al. (1992) previously recommended that staff gauges be installed at each check dam reservoir and riparian wetland site to enable easy estimation of water storage and water levels. Several shallow wells made of 50-75 mm diameter slotted PVC pipes could also be installed at both the created and natural wetlands to measure both surface water levels when standing water is

present, and ground water levels to depths of 0.5 to 2 m when soils are saturated below the surface (Horner and Raedeke 1989).

Other hydrological information that should be recorded include flow rates, which affects wetland characteristics and stability, and flow patterns of surface water, which influences plant establishment and substrate stability and chemistry (Kentula et al. 1992). Flumes and weirs can be used to measure flow rates at wetlands with distinct inlets or outlets (Kentula et al. 1992). Flow patterns should be described and recorded on as-built site maps during the site visit (Kentula et al. 1992). Soil and water chemistry at these wetlands could also be assessed and compared to see if these factors may also be influencing vegetation development.

Collecting and comparing this information for the natural and created wetlands will help determine if or where any significant hydrological differences exist. This information would aid in determining whether water regulation is necessary at these projects, and if so, the hydrological information from suitable natural wetland areas could be used to suggest appropriate water levels, and appropriate timing and duration of flooding or drawdown for this area.

5.1.3 Monitoring of muskrat populations and feeding damage at wetland projects

Grazing and cutting of emergents (cattail and bulrush) by muskrat has a major impact on the rate and pattern of emergent destruction in wetlands (Van Der Valk 1989). It is likely that muskrat feeding is contributing to the reduction of already sparse emergent cover at some of these wetland projects. In order to determine the extent of their influence, muskrat populations and their impact on emergent vegetation could be monitored.

5.2 Managing wetlands for wildlife

5.2.1 Controlling the level of human disturbance occurring in project areas and the adjacent uplands

Although vegetation at natural prairie wetlands evolved with disturbances such as grazing, fire, and muskrat feeding, the extent and intensity of human disturbances occurring in these wetland areas and in the adjacent upland is currently reducing the potential of these projects to provide replacement wildlife habitat. Several steps can be taken to reduce the amount of human disturbance currently occurring in the wetland project areas and in the adjacent uplands.

Protected wildlife habitat areas around these wetlands are currently very limited in size, so it is imperative that these areas should not be further reduced by grazing or haying within the mitigation project boundaries. Both grazing and mowing can be used as tools to create openings and increase habitat value of wetlands that have become overgrown by dense emergent cover (Kantrud 1986). In the current situation however, grazing and mowing is reducing already limited emergent vegetation and waterfowl nesting cover. If control of dense forage species within the mitigation land base is required to reduce vegetation competing with planted shrubs, or to make overly dense or monospecific growth more attractive to nesting waterfowl, carefully planned, selective weeding, cutting or burning would be a more appropriate means. Current haying leases within the mitigation land base should be phased out as soon as possible.

Management efforts to overcome habitat deficiencies on small tracts of land may be futile if the benefits of these small areas of habitat are swamped by the habitat degradation occurring on the

adjacent land (Ringelman 1992). In order to provide more nesting habitat in some of the potential nesting area which currently lies outside the protected boundaries, cooperation between the adjacent landowners or lease holders and Alberta Environmental Protection is required.

Incentive programs can be used to encourage adjacent landowners or lease holders to follow practices that would improve the quality of adjacent nesting habitat (Dornfeld and Warhurst 1988). Adjacent farmers could be requested to leave sufficient stubble on hay fields in the fall (preferably at least 30 cm tall), to provide some residual spring nesting cover for early nesting waterfowl. An arrangement could also be made to delay the haying of adjacent forage or other cropland until at least July 15, when the critical nesting period has passed for the majority of waterfowl (Watson, pers. comm. 1995). This is highly recommended, as haying during the nesting period will often kill the adult birds as well as their broods, eliminating any benefits that the ponds may have provided in terms of attracting and producing more waterfowl. In combination with delayed haying, requesting that adjacent farmers use a flushing bar while haying may also help to reduce losses of late nesting waterfowl, numerous upland bird species, and mammals such as porcupines, skunks, and deer fawns that are often killed by haying machinery.

Grazing of adjacent uplands at least within 300 m of the wetland should also be deferred until after July 15 to reduce damage to vegetation and nests during this time period. Severely overgrazed uplands in the vicinity of wetlands (in particular, OC26-C02, C19-C01, OC20-C01 and OC20-C02) that currently offer little or no upland nesting cover, should be allowed to recover to provide potential habitat, and to prevent eventual soil erosion. It would be beneficial to adjust future grazing intensity or timing in these areas to leave an appropriate amount of vegetation carryover in the fall to be used as nesting cover in the spring by birds that nest in this shorter native upland vegetation.

Any damaged or otherwise deficient cattle walkways (C19-C01, OC26-C02, CR25-C01) should be inspected and repaired. Grazing currently allowed within OC26-C02 and C19-C02 should not continue. Unlimited cattle access to wetlands results in damage to both the shoreline and to the quality of the water supply, sometimes rendering the water unfit for use. Although the walkways limit the extent of shoreline damage, they still allow the contamination of the water with cattle waste. This nutrient enrichment may lead to "algae blooms" that cause a depletion of dissolved oxygen when they die off. Some species of planktonic algae may also release toxins when they decay, rendering the water toxic to livestock and wildlife (Burland 1989). Many economically feasible, and highly effective methods can be used to provide both a fresh source of water for the cattle, and better habitat for wildlife[2]. An appropriate method could be chosen and implemented at selected sites, or incentives could be provided for ranchers to implement one of these methods on their own.

5.2.2 Repairing or replacing damaged or failed wildlife habitat enhancement measures

Nesting boxes (built for wood ducks and American kestrel) that have fallen into the ponds should be repaired or replaced to provide habitat for cavity nesting birds. Nesting box poles should be placed deeper in the ground than the previous ones, to provide the support needed to prevent them from toppling over.

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[2] A video based on the studies of Ducks unlimited agrologist, Dr. Wayne Cowan entitled "Quality Water For Livestock" demonstrates 12 different techniques used through out Manitoba, Saskatchewan, Alberta, Montana, and North Dakota to provide high quality water for livestock, while protecting wildlife habitat. These methods involve fencing off the wetland area and delivering water from the water source to the cattle using affordable methods including solar, wind, and cow powered pumps.

The mitigation plantings in the vicinity of the wetlands showed very low survival and growth largely as a result of deer browsing damage and competition with weedy forage species present at these sites. Corrective measures suggested for these planting projects are outlined in the 1995 assessment of the mitigation planting projects (Pichlyk 1996).

5.2.3 Creating additional nesting habitat at appropriate wetlands

At some of the larger wetlands that appear to be attracting a number of ducks in the spring, it may be beneficial to build and place an artificial nesting structure such as a nesting basket or cone to provide a safe stable nest site that can be used by mallards and several other types of ducks. A floating nesting raft or platform could also be placed at these ponds for possible nesting use, or to provide an additional loafing area for waterfowl (Alberta Fish and Wildlife nd[b]).

Even the largest of these ponds may be too small to justify the construction of a permanent vegetated nesting island for geese and waterfowl. Although this would provide additional waterfowl loafing or nesting sites, geese require ponds larger than 1 ha in size for brood rearing, and all of the ponds assessed were smaller than this. As well, because of the small wetland size, the distance between the shore and the island would generally be less than the recommended distance of 100-170 m (Alberta Fish and Wildlife nd[a]). Shorter distances would not likely offer nesting ducks and their broods sufficient protection from local predators (Giroux 1981). Coyotes, (Hanson and Everhardt 1971) and badgers (Duebbert 1967) have been observed to swim over 200 m without apparent stress. In southeastern Alberta, Giroux (1981), observed a skunk swimming between nesting islands over a distance of more than 200 m. Raccoons have also been noted to swim to muskrat lodges far from shore (Weller 1981).

5.2.4 Manipulating vegetation structure and/or composition at wetland projects

Corrective measures may be warranted if comparisons of vegetation communities at created wetlands and natural wetlands of this area identify major differences in species diversity, composition or abundance. If wetland vegetation communities similar to those at natural wetlands are not able to develop as a result of competition with aggressive or less desirable introduced or weedy species, or if surrounding vegetation is dominated by dense monocultures of such species, some method of vegetation manipulation may be required to improve the wildlife habitat value of these areas. Manipulating water levels (see section 5.2.5), grazing, mowing, herbicide use, prescribed burning, and seeding are a few of the methods that have been used to bring about a variety of vegetation changes in wetlands and the surrounding area to increase their value to wildlife (Fredrickson and Ried 1988, Fredrickson and Taylor 1982, Kantrud 1986, Kirby et al. 1988). Any such action should be carefully researched before proceeding to insure that it is the most appropriate method for the project area.

5.2.5 Manipulating water levels to influence vegetation development and increase wildlife habitat value at selected wetland projects

Water level manipulation could be used as a management tool in some sites if a comparison of the hydrology of the selected created wetlands and natural wetlands of the area shows that hydrological factors differ significantly, and that these differences are likely to prevent the created wetlands from ever developing vegetation and habitat values similar to those of natural wetlands.

Hydrological manipulation should only be attempted in those wetlands with otherwise suitable physical characteristics to allow vegetation development (i.e. wide, shallow basins with gentle bank slopes). Information currently exists on the effect of various water level manipulations on specific emergent vegetation species occurring in Canadian prairie wetlands (Shay and Shay 1986, Neill 1993, Liefeers and Shay 1980, Millar 1972). Guidelines exist for manipulating water levels to produce desired vegetation species, and to encourage specific wildlife use throughout the seasons (Alberta Fish and Wildlife nd[e], Fredrickson and Taylor 1982). Drawdowns in late fall / early winter can also be used to reduce muskrat populations before "eat outs" occur (Weller 1981). Existing information on ecological requirements for vegetation growth in this area, bird migration dates, and seasonal habitat requirements of key species in this region should be collected and reviewed prior to designing any water level manipulation programs.

Because plants respond to changes in water levels as small as one or two centimeters, structures used to manipulate water levels for vegetation development must also be capable of these precise changes (Fredrickson and Taylor 1982). Water control structures with removable stop logs of different widths (heights) are recommended for this purpose (Fredrickson and Taylor 1982, Ducks unlimited nd). The created wetland projects were not specifically designed with water manipulation in mind, so none of these have stop log type water control structure in place. However, three of the five type 3 wetlands (CR17-C01, OC05-C01, and OC05-C02) are listed on the as-built site maps as having 50 mm galvanized steel drainage pipes with gate control valves. Experimentation is required to determine whether these gate valves can be used "as is", or modified to achieve the precise water level manipulations required. Although drainage pipes should be placed at the lowest point in the basin to allow for complete de-watering of the wetland (Fredrickson and Taylor 1982, Ducks Unlimited nd), the drainage pipes at the created wetlands are located approximately 1 m above the lowest elevation of the basin (APWSS 1995). Based on the topographic maps of the wetlands however, this elevation is still sufficient to drain the majority of the wetland area at these sites.

Water level manipulation can also be achieved by adding or removing water using pumps (Weller 1981). This method produces natural results, but is generally expensive in equipment, time, and operational costs (Weller 1981). At some of the created wetlands, equipment that could be used for this purpose is already in place. The OC05 ponds are currently supplied with water from a solar powered pump in a series of wells in NE 34-7-30-4. A polyethylene line was buried from the wells to a point in the north end of the parcel, and the line is split to fill OC05-C01, C02, and C03 and to irrigate the tree and shrub plantings. Valves are provided to operate the system (APWSS 1995). Staff gages and/or PVC pipe wells placed at these wetlands could be used to monitor water levels as water is added or removed.

Any wetland vegetation management efforts should be carried out in a way that promotes a variety of wetland and cover types throughout the mitigation land base. Different wildlife species have different wetland type and cover preferences, and even individual species may utilize a variety of different wetland types through different stages of their life cycle. Caution should be used when undertaking measures to encourage one type of wetland use over another. Maintaining a diversity of wetland habitat types throughout the mitigation land base will benefit both waterfowl and other wildlife.

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Appendix I. Method used to estimate current water level

When calculating elevations of water levels, the top of dam elevation was taken from the construction bench mark on top of the dam, or if this was not present, it was assumed that the top of the dam height recorded in the as-built site map was roughly the same as the height of the dam at the base of the more recently placed rebar site markers.

A string was fastened to the top of the construction bench mark, or to a measured point on the rebar site marker on top of the dam. The string was then stretched out over the waters edge, and a metal measuring tape was used to determine the distance in cm that the current water level was below the top of dam elevation. A small line-level fastened to the string insured that the string was held at a right angle to the marker when the measurement was taken.

In the future, the addition of staff gages to each wetland would greatly facilitate the collection of water level information.

It may also be beneficial to re-survey any check dams that have undergone substantial repairs since the initial survey, or that were not completed at the time of survey, in order to determine the current dam top or spillway elevations.

Appendix II. Species lists and dominance ranks of plants seen in the wetland areas of each of the assessed wetland projects.

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Appendix IIa. Species list for wetland area of type 1 wetlands

Open water (submerged and floating aquatic species)

	C19-C01	C19-W01	C26-C01	C32-C01	CR08-C01	CR25-C03	OC05-W01	OC20-C01	OC20-C02	OC21-C01	OC26-C01	OC26-C02	OC26-C03	#	%	rank
Filamentous algae		1	1	1	1(2)	1	1(3)	1(4)	1(4)	1(4)	1(2)	1(4)	1(1)	12	92	4
Likely Cladophora sp.		1	1				1	1	1	1	1	1	1	9	69	
Likely Spirogyra sp.							1	1	1				1	4	31	
Macrophytic algae, Chara sp.				1(3)		1(4)		1	1(3)	1(1)		1(2)	1(1)	7	54	5
Submergent Aquatic Plants																
Callitriche hermaphroditica L.			1(2)	1(4)				1(3)			1(4)		1	5	38	6
Myriophyllum sibiricum Fern.			1(3)			1(3)	1(2)	1(1)		1(3)	1(1)	1(3)	1(2)	8	62	3
Potamogeton filiformis Pers.				1										1	8	
Potamogeton foliosus Raf.										1				1	8	
Potamogeton pectinatus L.							1	1				1		3	23	
Potamogeton pusillus L.									1					1	8	
Potamogeton spp. (lf./fl. too gen or sm)				1(1)		1(1)	1(1)	1(4)	1(1)	1(2)		1(1)		7	54	2
Potamogeton richardsonii (Benn.)Rydb.			1(1)	1(2)	1(1)	1(2)	1(3)	1(2)	1(2)		1(3)	1(4)	1(3)	10	77	1
Potamogeton vaseyi Fern.									1					1	8	
Ranunculus circinatus Sibth.				1				1			1		1	4	31	
Zannichellia palustris L.							1(4)							1	8	7
Floating Aquatic Lemna minor L.	1				1									2	15	

Emergent species

	C19-C01	C19-W01	C26-C01	C32-C01	CR08-C01	CR25-C03	OC05-W01	OC20-C01	OC20-C02	OC2-C01	OC26-C01	OC26-C02	OC26-C03			
Scirpus acutus Muhl. ex. Bigel.					1		1				1			3	23	
Scirpus sp. (likely acutus or pal.)					1		1				1			3	23	
Typha latifolia L.	1	1	1		1(1)	1	1	1(3)	1(5)	1(5)	1(3)	1(1)	1(4)	12	92	3

Shallow marsh species

	C19-C01	C19-W01	C26-C01	C32-C01	CR08-C01	CR25-C03	OC05-W01	OC20-C01	OC20-C02	OC2-C01	OC26-C01	OC26-C02	OC26-C03			
Alisma plantago-aquatica L.		1	1	1					1	1				5	38	
Alopecurus aequalis Sobol.					1									1	8	
Beckmannia syzigachne (Steud.) Fern.		1		1(2)	1	1(4)	1	1			1(1)			7	54	6
Bidens cernua L.						1						1	1	3	23	
Carex aquatilis Wahlenb.												1		1	8	
Carex lenticularis Michx.	1											1	1	3	23	
Carex rostrata Stokes (C. utriculata)												1	1	2	15	
Carex sp. (likely spp. long. root	1(3)	1(5)	1	1	1	1		1	1		1	1(5)	1(2)	11	85	8
Eleocharis palustris (L.) R. & S.	1	1	1	1(5)	1(2)	1	1	1(1)	1(3)	1(3)	1(2)	1	1	13	100	3
Glyceria borealis (Nash) Batchelder												1		1	8	
Glyceria grandis S. Wats. ex A. Gray		1		1	1(3)						1		1	5	38	10
Glyceria striata (Lam.) A.S. Hitchc.								1					1	2	15	
Hippuris vulgaris L.										1				1	8	
Limosella aquatica L.				1					1		1			4	31	
Phalaris arundinacea L.				1(1)		1				1(2)	1	1(3)	1	6	46	5
Polygonum coccineum Muhl.					1									1	8	

Appendix IIa. Species list for wetland area of type 1 wetlands

Open water (submerged and floating aquatic species)

	C19-C01	C19-W01	C26-C01	C32-C01	CR08-C01	CR25-C03	OC05-W01	OC20-C01	OC20-C02	OC21-C01	OC26-C01	OC26-C02	OC26-C03	#	%	rank
Filamentous algae		1	1	1	1(2)	1	1(3)	1(4)	1(4)	1(4)	1(2)	1(4)	1(1)	12	92	4
Likely Cladophora sp.		1	1				1	1	1	1	1	1	1	9	69	
Likely Spirogyra sp.							1	1	1				1	4	31	
Macrophytic algae, Chara sp.				1(3)		1(4)		1	1(3)	1(1)		1(2)	1(1)	7	54	5
Submergent Aquatic Plants																
Callitriche hermaphroditica L.			1(2)	1(4)				1(3)			1(4)		1	5	38	6
Myriophyllum exalbescens Fern.			1(3)			1(3)	1(2)	1(1)		1(3)	1(1)	1(3)	1(2)	8	62	3
Potamogeton filiformis Pers.				1										1	8	
Potamogeton foliosus Raf.										1				1	8	
Potamogeton pectinatus L.							1	1				1		3	23	
Potamogeton pusillus L.									1					1	8	
Potamogeton spp. (filiform, pusillus or sp.)				1(1)		1(1)	1(1)	1(4)	1(1)	1(2)		1(1)		7	54	2
Potamogeton richardsonii (Benn.)Rydb.			1(1)	1(2)	1(1)	1(2)	1(3)	1(2)	1(2)		1(3)	1(4)	1(3)	10	77	1
Potamogeton zosteriformis Fern.									1					1	8	
Ranunculus circinatus Sibth.				1				1			1		1	4	31	
Zannichellia palustris L.							1(4)							1	8	7
Floating Aquatic *Lemna minor L.*	1				1									2	15	

Emergent species

	C19-C01	C19-W01	C26-C01	C32-C01	CR08-C01	CR25-C03	OC05-W01	OC20-C01	OC20-C02	OC2-C01	OC26-C01	OC26-C02	OC26-C03			
Scirpus acutus Muhl. ex. Bigel.					1		1				1			3	23	
Scirpus sp. (likely acutus or pal.)					1		1				1			3	23	
Typha latifolia L.	1	1	1		1(1)	1	1	1(3)	1(5)	1(5)	1(3)	1(1)	1(4)	12	92	3

Shallow marsh species

	C19-C01	C19-W01	C26-C01	C32-C01	CR08-C01	CR25-C03	OC05-W01	OC20-C01	OC20-C02	OC2-C01	OC26-C01	OC26-C02	OC26-C03			
Alisma plantago-aquatica L.		1	1	1					1	1				5	38	
Alopecurus aequalis Sobol.					1									1	8	
Beckmannia syzigachne (Steud.) Fern.		1		1(2)	1	1(4)	1	1			1(1)			7	54	6
Bidens cernua L.						1						1	1	3	23	
Carex aquatilis Wahlenb.												1		1	8	
Carex lenticularis Michx.	1											1	1	3	23	
Carex rostrata Stokes (C. utriculata)												1	1	2	15	
Carex sp (likely aqu, lent, ros)	1(3)	1(5)	1	1	1	1		1	1		1	1(5)	1(2)	11	85	8
Eleocharis palustris (L.) R. & S.	1	1	1	1(5)	1(2)	1	1	1(1)	1(3)	1(3)	1(2)	1	1	13	100	3
Glyceria borealis (Nash) Batchelder												1		1	8	
Glyceria grandis S. Wats. ex A. Gray		1		1	1(3)						1		1	5	38	10
Glyceria striata (Lam.) A.S. Hitchc.								1					1	2	15	
Hippuris vulgaris L.										1				1	8	
Limosella aquatica L.				1					1		1			4	31	
Phalaris arundinacea L.				1(1)		1				1(2)	1	1(3)	1	6	46	5
Polygonum coccineum Muhl.					1									1	8	

Appendix IIa. Species list for wetland area of type 1 wetlands (continued)

Shoreline and drawdown species (including wet meadow and disturbed species from Millar 1976)

	C19-C01	C19-W01	C26-C01	C32-C01	CR08-C01	CR25-C03	OC05-W01	OC20-C01	OC20-C02	OC2-C01	OC26-C01	OC26-C02	OC26-C03	#	%	rank
Achillea millefolium L.			1						1		1	1	1	5	38	
Agropyron pectiniforme R. & S.		1												1	8	
Agropyron repens (L.) Beauv.		1(2)	1(4)	1	1(5)	1(2)	1(2)	1	1	1(1)	1			10	77	3
Agropyron subtile or dasystachyum	1					1			1			1	1	5	38	
Agropyron trachycaulum or spicatum	1		1			1		1				1	1	6	46	
Agrostis stolonifera L.	1(5)	1	1	1	1(4)	1(3)	1(4)	1		1	1	1(4)	1(1)	12	92	4
Agrostis sp.		1									1			2	15	
Arctium minus (Hill) Bernh.													1	1	8	
Artemisia biennis Willd.	1	1	1	1		1					1			6	46	
Artemisia ludoviciana Nutt.	1					1		1				1	1	5	38	
Aster ericoides L.	1		1		1	1		1			1	1	1	8	62	
Aster laevis L.	1	1			1			1	1			1	1	7	54	
Aster sp.			1						1		1			3	23	
Avena fatua L.										1				1	8	
Bromus commutatus Schrad.						1								1	8	
Bromus inermis Leyss.	1	1		1	1	1	1(3)	1	1(4)	1(4)	1	1	1(3)	12	92	7
Calamagrostis spp.												1	1	2	15	
Carex athrostachya Olney	1													1	8	
Carex filifolia Nutt.1							1							1	8	
Carex praegracilis W. Boott			1											1	8	
Cicuta maculata L.					1							1	1	3	23	
Cirsium arvense (L.) Scop.	1	1	1	1	1	1	1	1	1	1	1	1	1(5)	13	100	12
Cirsium undulatum (Nutt.) Spreng.													1	1	8	
Cirsium vulgare (Savi) Ten.			1			1		1	1		1	1	1	7	54	
Coreopsis orientalis (L.) Dum.									1					1	8	
Crucifer(alys aly,lepi den,camo mic,card cha)					1		1	1	1		1	1		6	46	
Cynoglossum officinale L.												1	1	2	15	
Deschampsia caespitosa (L.) Beauv.		1	1		1	1		1				1	1	7	54	
Descurainia sophia (L.) Webb							1							1	8	
Eleocharis acicularis (L.) R. & S.				1(4)										1	8	11
Elymus sp.						1								1	8	
Epilobium ciliatum Raf.	1		1	1	1	1	1	1	1	1	1	1(2)	1	12	92	9
Equisetum arvense L.		1			1					1				3	23	
Equisetum hyemale L.	1												1	2	15	
Equisetum pratense Ehrh.	1													1	8	
Equisetum sp. (arv, hye, or pra)	1	1			1					1			1	5	38	
Galium boreale L.													1	1	8	
Geum triflorum Pursh (G.rivale L.?)		1												1	8	
Grindelia squarrosa (Pursh) Dunal			1	1				1						3	23	
Helianthus annuus L.		1							1					2	15	
Helianthus nuttallii T. & G.				1	1					1		1	1	5	38	
Helianthus spp. (ann &/or nutt)		1		1	1				1	1		1	1	7	54	

Appendix IIa Species list for wetland area of type 1 wetlands (continued)

Shoreline and drawdown species (including wet meadow and disturbed species from Millar 1976)

	C19-C01	C19-W01	C26-C01	C32-C01	CR08-C01	CR25-C03	OC05-W01	OC20-C01	OC20-C02	OC2-C01	OC26-C01	OC26-C02	OC26-C03	#	%	rank
Hordeum jubatum L.	1(2)	1(4)	1(1)	1	1	1	1(1)	1(5)	1(1)	1	1(4)	1	1	13	100	2
Juncus balticus Willd.	1	1	1(5)		1			1	1		1	1	1	9	69	12
Juncus bufonius L.										1		1	1	3	23	
Juncus longistylis Torr.					1			1						2	15	
Juncus nodosus L.	1	1			1							1	1	5	38	
Juncus torreyi Coville											1			1	8	
Juncus sp. (likely nod,torr, long)				1		1								2	15	
Koeleria macrantha (Ledeb.) J.A. Schultes f.										1				1	8	
Lactuca serriola L.						1								1	8	
Medicago lupulina L.					1	1			1			1	1	5	38	
Melilotus officinalis (L.) Lam.					1	1					1			3	23	
Mentha arvensis L.	1	1		1	1				1			1	1	7	54	
Phleum pratense L.	1(4)	1(1)	1(3)	1	1	1(5)	1	1(4)	1(2)	1	1	1	1	13	100	4
Plantago major L.	1	1			1			1	1		1			6	46	
Poa compressa L.	1			1	1	1	1	1	1		1			8	62	
Poa palustris L.	1	1			1			1						4	31	
Poa pratensis L.	1			1	1	1	1	1	1	1	1	1	1	11	85	
Poa spp. (either com &/or pal &/or pra)	1(1)	1(3)	1(2)	1(3)	1	1(1)	1(5)	1(2)	1	1	1(5)	1	1	13	100	1
Polygonum lapathifolium L.	1													1	8	
Populus balsamifera L.					1									1	8	
Potentilla norvegica L.				1										1	8	
Ranunculus sceleratus L.	1	1	1						1		1	1		6	46	
Rhus trilobata Nutt.													1	1	8	
Rorippa palustris (L.) Besser	1	1			1	1								4	31	
Rosa spp. (acic &/or woo &/or ark)		1				1			1	1	1	1	1	7	54	
Rubus idaeus L.					1									1	8	
Rumex crispus L.									1					1	8	
Rumex triangulivalvis (Danser) Rech. f.	1	1	1		1	1	1	1		1	1		1	10	77	
Salix spp. (argyo, discolor etc.)	1			1	1	1		1	1	1			1	8	62	
Sanicula stellata (L.) Desf.													1	1	8	
Solidago canadensis L. (gigantea?)												1	1	2	15	
Solidago missouriensis Nutt. (spathulata DC.?)								1						1	8	
Sonchus arvensis L.	1					1								2	15	
Stachys palustris L.					1									1	8	
Stipa viridula Trin.												1		1	8	
Symphoricarpos occidentalis Hook.		1			1		1		1		1	1	1	7	54	
Taraxacum officinale Weber	1	1	1	1				1					1	6	46	
Thalictrum occidentale A. Gray (venulosum?)													1	1	8	
Thermopsis rhombifolia (Nutt.) Richards.													1	1	8	
Thlaspi arvense L.		1								1				2	15	
Tragopogon dubius Scop.						1	1		1					3	23	
Trifolium repens L.					1			1	1					3	23	
Vicia americana Muhl.													1	1	8	

Appendix IIa. Species list for wetland area of type 1 wetlands (continued)

Shoreline and drawdown species (including wet meadow and disturbed species from Millar 1976)

	C19-C01	C19-W01	C26-C01	C32-C01	CR08-C01	CR25-C03	OC05-W01	OC20-C01	OC20-C02	OC2-C01	OC26-C01	OC26-C02	OC26-C03	#	%	rank
Achillea millefolium L.			1						1		1	1	1	5	38	
Agropyron pectiniforme R. & S.		1												1	8	
Agropyron repens (L.) Beauv.		1(2)	1(4)	1	1(5)	1(2)	1(2)	1	1	1(1)	1			10	77	3
Agropyron smithii or dasystachyum	1					1			1			1	1	5	38	
Agropyron trachyculum or spicatum	1		1			1		1				1	1	6	46	
Agrostis stolonifera L.	1(5)	1	1	1	1(4)	1(3)	1(4)	1		1	1	1(4)	1(1)	12	92	4
Agrostis sp.		1									1			2	15	
Arctium minus (Hill) Bernh.													1	1	8	
Artemisia biennis Willd.	1	1	1	1		1					1			6	46	
Artemisia ludoviciana Nutt.	1					1		1				1	1	5	38	
Aster ericoides L.	1		1		1	1		1			1	1	1	8	62	
Aster laevis L.	1	1			1			1	1			1	1	7	54	
Aster sp.			1						1		1			3	23	
Avena fatua L.										1				1	8	
Bromus commutatus Schrad.						1								1	8	
Bromus inermis Leyss.	1	1		1	1	1	1(3)	1	1(4)	1(4)	1	1	1(3)	12	92	7
Calamagrostis spp.												1	1	2	15	
Carex atherostachya Olney	1													1	8	
Carex filifolia Nutt.l							1							1	8	
Carex praegracilis W. Boott			1											1	8	
Cicuta maculata L.					1							1	1	3	23	
Cirsium arvense (L.) Scop.	1	1	1	1	1	1	1	1	1	1	1	1	1(5)	13	100	12
Cirsium undulatum (Nutt.) Spreng.													1	1	8	
Cirsium vulgare (Savi) Ten.			1			1		1	1		1	1	1	7	54	
Couringia orientalis (L.) Dum.									1					1	8	
Crucifer(alys aly,lepi dan,camе mic,card cha)					1		1	1	1		1	1		6	46	
Cynoglossum officinale L.												1	1	2	15	
Deschampsia cespitosa (L.) Beauv.		1	1		1	1		1				1	1	7	54	
Descurainia sophia (L.) Webb							1							1	8	
Eleocharis acicularis (L.) R. & S.				1(4)										1	8	11
Elymus sp.						1								1	8	
Epilobium ciliatum Raf.	1		1	1	1	1	1	1	1	1	1	1(2)	1	12	92	9
Equisetum arvense L.		1			1					1				3	23	
Equisetum hyemale L.	1												1	2	15	
Equisetum pratense Ehrh.	1													1	8	
Equisetum sp. (arv, hye, or pra)	1	1			1					1			1	5	38	
Galium boreale L.													1	1	8	
Geum triflorum Pursh (G.rivale L.?)		1												1	8	
Grindelia squarrosa (Pursh) Dunal			1	1				1						3	23	
Helianthus annuus L.		1							1					2	15	
Helianthus nuttallii T. & G.				1	1					1		1	1	5	38	
Helianthus spp. (ann &/or nutt)		1		1	1				1	1		1	1	7	54	

Appendix IIa Species list for wetland area of type 1 wetlands (continued)

Shoreline and drawdown species (including wet meadow and disturbed species from Millar 1976)

	C19-C01	C19-W01	C26-C01	C32-C01	CR08-C01	CR25-C03	OC05-W01	OC20-C01	OC20-C02	OC2-C01	OC26-C01	OC26-C02	OC26-C03	#	%	rank
Hordeum jubatum L.	1(2)	1(4)	1(1)	1	1	1	1(1)	1(5)	1(1)	1	1(4)	1	1	13	100	2
Juncus balticus Willd.	1	1	1(5)		1			1	1		1	1	1	9	69	12
Juncus bufonius L.										1		1	1	3	23	
Juncus longistylis Torr.					1			1						2	15	
Juncus nodosus L.	1	1			1							1	1	5	38	
Juncus torreyi Coville											1			1	8	
Juncus sp. (likely nod,torr, long)				1		1								2	15	
Koeleria macrantha (Ledeb.) J.A. Schultes f.										1				1	8	
Lactuca serriola L.						1								1	8	
Medicago lupulina L.					1	1			1			1	1	5	38	
Melilotus officinalis (L.) Lam.					1	1					1			3	23	
Mentha arvensis L.	1	1		1	1				1			1	1	7	54	
Phleum pratense L.	1(4)	1(1)	1(3)	1	1	1(5)	1	1(4)	1(2)	1	1	1	1	13	100	4
Plantago major L.	1	1			1			1	1		1			6	46	
Poa compressa L.	1			1	1	1	1	1	1		1			8	62	
Poa palustris L.	1	1			1			1						4	31	
Poa pratensis L.	1			1	1	1	1	1	1	1	1	1	1	11	85	
Poa spp. (other cow &/or pal &/or pra)	1(1)	1(3)	1(2)	1(3)	1	1(1)	1(5)	1(2)	1	1	1(5)	1	1	13	100	1
Polygonum lapathifolium L.	1													1	8	
Populus balsamifera L.					1									1	8	
Potentilla norvegica L.				1										1	8	
Ranunculus sceleratus L.	1	1	1						1		1	1		6	46	
Rhus trilobata Nutt.													1	1	8	
Rorippa palustris (L.) Besser	1	1			1	1								4	31	
Rosa spp. (acic &/or woo &/or ark)		1				1			1	1	1	1	1	7	54	
Rubus idaeus L.					1									1	8	
Rumex crispus L.									1					1	8	
Rumex triangulivalvis (Danser) Rech. f.	1	1	1		1	1	1	1		1	1		1	10	77	
Salix spp. (exigua, discolor etc.)	1			1	1	1		1	1	1			1	8	62	
Stellaria stellata (L.) Dasf.													1	1	8	
Solidago canadensis L. (gigantea?)												1	1	2	15	
Solidago missouriensis Nutt. (spathulata DC.?)								1						1	8	
Sonchus arvensis L.	1					1								2	15	
Stachys palustris L.					1									1	8	
Stipa viridula Trin.												1		1	8	
Symphoricarpos occidentalis Hook.		1			1		1		1		1	1	1	7	54	
Taraxacum officinale Weber	1	1	1	1				1					1	6	46	
Thalictrum occidentale A. Gray (venulosum?)													1	1	8	
Thermopsis rhombifolia (Nutt.) Richards.													1	1	8	
Thlaspi arvense L.		1								1				2	15	
Tragopogon dubius Scop.						1	1		1					3	23	
Trifolium repens L.					1			1	1					3	23	
Vicia americana Muhl.													1	1	8	

Appendix IIb. Species list for wetland area of type 2 wetlands

Open water (submerged and floating aquatic species)

	C26-C02	C19-C02	C20-C01	CR25-C01	CR25-C02	C32 "small"	OC21-C02	#	%	rank
Filamentous algae		1	1(3)	1(1)	1(3)	1	1(3)	6	100	2
Likely Cladophora sp.				1	1		1	3	50	
Likely Spirogyra sp.		1	1		1			3	50	
Macrophytic algae, *Chara sp.*		1(1)			1(1)	1(1)	1(3)	4	67	1
Submergent Aquatic Plants										
Myriophyllum exalbescens Fern.							1(2)	1	17	4
Potamogeton filiformis Pers.					1			1	17	
Potamogeton foliosus Raf.				1	1		1	3	50	
Potamogeton pectinatus L.			1				1	2	33	
Potamogeton (fil,fol, pec,gra or zos)			1(2)	1(1)	1(2)		1(1)	4	67	1
Potamogeton richardsonii (Benn.)Rydb.		1(1)	1(1)					2	33	3

Emergent species

	C26-C02	C19-C02	C20-C01	CR25-C01	CR25-C02	C32 "small"	OC21-C02			
Scirpus acutus Muhl. ex. Bigel.							1	1	17	
Scirpus sp. (likely acutus or pal.)			1	1			1	3	50	10
Typha latifolia L.			1(4)	1	1(1)	1	1(2)	5	83	4

Shallow marsh species

	C26-C02	C19-C02	C20-C01	CR25-C01	CR25-C02	C32 "small"	OC21-C02			
Beckmannia syzigachne (Steud.) Fern.						1		1	17	
Carex sp (likely aqu, lang, ros)		1(5)						1	17	10
Eleocharis palustris (L.) R. & S.		1	1(2)	1(2)	1(5)	1(3)	1(3)	6	100	2
Phalaris arundinacea L.			1(1)			1(1)	1(1)	3	50	2
Scirpus pungens Vahl			1					1	17	
Sparganium angustifolium Michx.			1					1	17	10

Shoreline and drawdown species (including wet meadow and disturbed species from Millar 1976)

	C26-C02	C19-C02	C20-C01	CR25-C01	CR25-C02	C32 "small"	OC21-C02			
Achillea millefolium L.	1	1		1	1			4	57	
Agropyron repens (L.) Beauv.	1	1(2)		1(4)		1(2)	1(5)	5	71	5
Agropyron smithii or dasystachyum	1	1(2)			1	1		4	57	7
Agropyron trachycaulum or spicatum	1(4)							1	14	9
Agrostis stolonifera L.		1		1(3)	1			3	43	8
Artemisia frigida Willd.	1	1		1				3	43	
Artemisia ludoviciana Nutt.		1		1	1			3	43	
Aster ericoides L.	1			1	1		1	4	57	
Aster laevis L.					1		1	2	29	
Avena fatua L.							1	1	14	
Bromus commutatus Schrad.		1			1			2	29	
Bromus inermis Leyss.	1		1	1			1	4	57	
Cardaria draba (L.) Desv.			1					1	14	
Carex filifolia Nutt.l		1						1	14	
Carex praegracilis W. Boott	1							1	14	
Carex sp (stenophylla-like).	1			1				2	29	
Cicuta maculata L.				1				1	14	
Cirsium arvense (L.) Scop.	1	1	1	1(5)	1(4)	1	1	7	100	8
Cirsium vulgare (Savi) Ten.				1	1			2	29	
Crucifer(alys aly,lepi dan,cama mic,card cha)			1				1	2	29	
Deschampsia cespitosa (L.) Beauv.					1			1	14	
Epilobium ciliatum Raf.		1			1		1	3	43	
Equisetum sp. (arv, hye, or pra)					1			1	14	
Grindelia squarrosa (Pursh) Dunal	1	1			1	1		4	57	
Helianthus nuttallii T. & G.	1					1		2	29	
Helianthus spp. (ann &/or nutt)	1					1		2	29	
Hordeum jubatum L.	1(1)	1(3)		1	1(2)	1(4)	1	6	86	3
Juncus balticus Willd.		1						1	14	
Juncus sp.(likely ned,torr, long)						1		1	14	

Appendix IIb Species list for wetland area of type 2 wetlands (continued)

Shoreline and drawdown species (including wet meadow and disturbed species from Millar 1976)

	C26-C02	C19-C02	C20-C01	CR25-C01	CR25-C02	C32 "small"	OC21-C02	#	%	rank
Koeleria macrantha (Ledeb.) J.A. Schultes f.				1				1	14	
Medicago lupulina L.				1				1	14	
Medicago sativa L.			1					1	14	
Melilotus officinalis (L.) Lam.				1				1	14	
Muhlenbergia cuspidata (Torr.) Rydb.		1						1	14	
Phleum pratense L.	1(3)	1(4)	1	1	1		1	6	86	6
Poa compressa L.		1	1	1	1	1	1	6	86	
Poa pratensis L.	1	1	1	1	1	1	1	7	100	
Poa spp. (either com &/or pal &/or pra)	1(2)	1(1)	1(3)	1(1)	1(3)	1(3)	1(4)	7	100	1
Polygonum aranastrum Jord. ex. Bor.	1(5)							1	14	
Rathida columnifera (Nutt.) Wooton & Standl.		1						1	14	
Rosa spp. (acic &/or woo &/or ark)	1						1	2	29	
Rumex triangulivalvis (Dans.) Rech. f.							1	1	14	
Salix spp. (exigua, discolor etc.)			1				1	2	29	
Sisyrinchium montanum Greene							1	1	14	
Stipa viridula Trin.	1			1				2	29	
Symphoricarpos occidentalis Hook.	1			1			1	3	43	10
Taraxacum officinale Weber	1	1				1	1	4	57	
Thermopsis rhombifolia (Nutt.) Richards.				1				1	14	
Thlaspi arvense L.	1							1	14	
Trifolium repens L.		1					1	2	29	
Vicia americana Muhl.			1	1				2	29	

Appendix IIb. Species list for wetland area of type 2 wetlands

Open water (submerged and floating aquatic species)

	C26-C02	C19-C02	C20-C01	CR25-C01	CR25-C02	C32 "small"	OC21-C02	#	%	rank
Filamentous algae		1	1(3)	1(1)	1(3)	1	1(3)	6	100	2
Likely Cladophora sp.				1	1		1	3	50	
Likely Spirogyra sp.		1	1		1			3	50	
Macrophytic algae, *Chara sp.*		1(1)			1(1)	1(1)	1(3)	4	67	1
Submergent Aquatic Plants										
Myriophyllum exalbescens Fern.							1(2)	1	17	4
Potamogeton filiformis Pers.					1			1	17	
Potamogeton foliosus Raf.				1	1		1	3	50	
Potamogeton pectinatus L.			1				1	2	33	
Potamogeton (fil,fol, pec,gra or zos)			1(2)	1(1)	1(2)		1(1)	4	67	1
Potamogeton richardsonii (Benn.)Rydb.		1(1)	1(1)					2	33	3

Emergent species

	C26-C02	C19-C02	C20-C01	CR25-C01	CR25-C02	C32 "small"	OC21-C02			
Scirpus acutus Muhl. ex. Bigel.							1	1	17	
Scirpus sp. (likely acutus or pal.)			1	1			1	3	50	10
Typha latifolia L.			1(4)	1	1(1)	1	1(2)	5	83	4

Shallow marsh species

	C26-C02	C19-C02	C20-C01	CR25-C01	CR25-C02	C32 "small"	OC21-C02			
Beckmannia syzigachne (Steud.) Fern.						1		1	17	
Carex sp. (likely aqu, lasi, ros)		1(5)						1	17	10
Eleocharis palustris (L.) R. & S.		1	1(2)	1(2)	1(5)	1(3)	1(3)	6	100	2
Phalaris arundinacea L.			1(1)			1(1)	1(1)	3	50	2
Scirpus pungens Vahl			1					1	17	
Sparganium angustifolium Michx.			1					1	17	10

Shoreline and drawdown species (including wet meadow and disturbed species from Millar 1976)

	C26-C02	C19-C02	C20-C01	CR25-C01	CR25-C02	C32 "small"	OC21-C02			
Achillea millefolium L.	1	1		1	1			4	57	
Agropyron repens (L.) Beauv.	1	1(2)		1(4)		1(2)	1(5)	5	71	5
Agropyron smithii or dasystachyum	1	1(2)			1	1		4	57	7
Agropyron trachycaulum or spicatum	1(4)							1	14	9
Agrostis stolonifera L.		1		1(3)	1			3	43	8
Artemisia frigida Willd.	1	1		1				3	43	
Artemisia ludoviciana Nutt.		1		1	1			3	43	
Aster ericoides L.	1			1	1		1	4	57	
Aster laevis L.					1		1	2	29	
Avena fatua L.							1	1	14	
Bromus commutatus Schrad.		1			1			2	29	
Bromus inermis Leyss.	1		1	1			1	4	57	
Cardaria draba (L.) Desv.			1					1	14	
Carex filifolia Nutt.l		1						1	14	
Carex praegracilis W. Boott	1							1	14	
Carex sp (stenophylla-like).	1			1				2	29	
Cicuta maculata L.				1				1	14	
Cirsium arvense (L.) Scop.	1	1	1	1(3)	1(4)	1	1	7	100	8
Cirsium vulgare (Savi) Ten.				1	1			2	29	
Crucifer(alys sty,lepi den,camo mic,sard cha)			1				1	2	29	
Deschampsia cespitosa (L.) Beauv.					1			1	14	
Epilobium ciliatum Raf.		1			1		1	3	43	
Equisetum sp. (arv, hye, or pra)					1			1	14	
Grindelia squarrosa (Pursh) Dunal	1	1			1	1		4	57	
Helianthus nuttallii T. & G.	1					1		2	29	
Helianthus spp. (tom dyb or nut)	1					1		2	29	
Hordeum jubatum L.	1(1)	1(3)		1	1(2)	1(4)	1	6	86	3
Juncus balticus Willd.		1						1	14	
Juncus sp. (likely ned,arc, long)						1		1	14	

Appendix IIb Species list for wetland area of type 2 wetlands (continued)

Shoreline and drawdown species (including wet meadow and disturbed species from Millar 1976)

	C26-C02	C19-C02	C20-C01	CR25-C01	CR25-C02	C32 "small"	OC21-C02	#	%	rank
Koeleria macrantha (Ledeb.) J.A. Schultes f.				1				1	14	
Medicago lupulina L.				1				1	14	
Medicago sativa L.			1					1	14	
Melilotus officinalis (L.) Lam.				1				1	14	
Muhlenbergia cuspidata (Torr.) Rydb.		1						1	14	
Phleum pratense L.	1(3)	1(4)	1	1	1		1	6	86	6
Poa compressa L.		1	1	1	1	1	1	6	86	
Poa pratensis L.	1	1	1	1	1	1	1	7	100	
Poa spp. (either com d/or pal d/or pra)	1(2)	1(1)	1(3)	1(1)	1(3)	1(3)	1(4)	7	100	1
Polygonum aroastrum Jord. ex. Bor.	1(5)							1	14	
Rudbeckia columnifera (Nutt.) Wooton & Standl.		1						1	14	
Rosa spp. (acic d/or woo d/or ark)	1						1	2	29	
Rumex triangulivalvis (Danser) Rech. f.							1	1	14	
Salix spp. (exigua, discolor etc.)			1				1	2	29	
Sisyrinchium montanum Greene							1	1	14	
Stipa viridula Trin.	1			1				2	29	
Symphoricarpos occidentalis Hook.	1			1			1	3	43	10
Taraxacum officinale Weber	1	1				1	1	4	57	
Thermopsis rhombifolia (Nutt.) Richards.				1				1	14	
Thlaspi arvense L.	1							1	14	
Trifolium repens L.		1					1	2	29	
Vicia americana Muhl.			1	1				2	29	

Appendix IIc. Species list for wetland area of type 3 wetlands

Open water (submerged and floating aquatic species)

	CR17-C01	OC05-C01	OC05-C02	OC05-C03	CR25-C04	#	%	rank
Filamentous algae	1	1(2)	1(1)	1(1)	1	5	100	1
Likely Cladophora sp.		1	1	1		3	60	
Likely Spirogyra sp.				1		1	20	
Macrophytic algae, *Chara sp.*		1	1(4)			2	40	5
Submergent Aquatic Plants								
Myriophyllum exalbescens Fern.		1(1)	1(3)	1(2)	1	4	80	2
Potamogeton pectinatus L.			1			1	20	
Potamogeton pusillus L.		1				1	20	
Potamogeton (fil,fol, pec, pus or zos)		1(2)	1(1)			2	40	3
Potamogeton richardsonii (Benn.)Rydb.			1(2)		1	2	40	4
Ranunculus circinatus Sibth.			1			1	20	

Emergent species

	CR17-C01	OC05-C01	OC05-C02	OC05-C03	CR25-C04			
Scirpus acutus Muhl. ex. Bigel.			1	1	1	3	60	
Scirpus paludosus A.Nels.				1		1	20	
Scirpus sp. (likely acutus or pal.)			1	1	1	3	60	
Typha lasifolia L.		1	1	1	1	4	80	

Shallow marsh species

	CR17-C01	OC05-C01	OC05-C02	OC05-C03	CR25-C04			
Beckmannia syzigachne (Steud.) Fern.		1		1(3)		2	40	7
Bidens cernua L.				1		1	20	
Carex lanuginosa Michx.		1				1	20	
Carex sp (likely aqu, lang, ros)					1	1	20	
Eleocharis palustris (L.) R. & S.		1	1	1	1(2)	4	80	5
Glyceria borealis (Nash) Batchelder		1	1(5)			2	40	7
Glyceria grandis S. Wats. ex A. Gray				1		1	20	
Glyceria striata (Lam.) A.S. Hitchc.		1(4)	1	1		3	60	6
Hippuris vulgaris L.			1			1	20	
Limosella aquatica L.					1	1	20	
Phalaris arundinacea L.		1		1		2	40	
Sparganium angustifolium Michx.					1	1	20	

Shoreline and drawdown species (including wet meadow and disturbed species from Millar 1976)

	CR17-C01	OC05-C01	OC05-C02	OC05-C03	CR25-C04			
Achillea millefolium L.		1				1	20	
Agropyron repens (L.) Beauv.	1(2)	1(1)	1(2)	1(1)	1(3)	5	100	1
Agropyron smithii or dasystachyum					1	1	20	
Agropyron trachycaulum or spicatum		1	1	1		3	60	
Agrostis stolonifera L.		1		1	1(4)	3	60	6
Artemisia biennis Willd.		1	1			2	40	
Artemisia frigida Willd.				1	1	2	40	
Artemisia ludoviciana Nutt.			1			1	20	
Aster ericoides L.				1		1	20	
Aster laevis L.				1		1	20	
Aster sp.				1		1	20	
Astragalus sp.		1				1	20	
Avena fatua L.				1		1	20	
Bromus commutatus Schrad.		1		1	1	3	60	
Bromus inermis Leyss.	1(1)	1	1	1	1	5	100	4

Appendix IIc. Species list for wetland area of type 3 wetlands (continued)

Shoreline and drawdown species (including wet meadow and disturbed species from Millar 1976)

	CR17-C01	OC05-C01	OC05-C02	OC05-C03	CR25-C04	#	%	rank
Carex flifolia Nutt.					1	1	20	
Carex sp (stenophylla-like).		1	1			2	40	
Chenopodium sp.			1			1	20	
Cirsium arvense (L.) Scop.	1(5)	1(5)	1(3)	1(4)	1	5	100	3
Cirsium vulgare (Savi) Ten.		1	1	1		3	60	
Crucifer(alya aly,lepi den,came mic,card cha)		1	1	1	1	4	80	
Cynoglossum officinale L.			1			1	20	
Deschampsia cespitosa (L.) Beauv.		1			1	2	40	
Descurainia sophia (L.) Webb		1				1	20	
Elymus sp.				1		1	20	
Epilobium ciliatum Raf.		1	1	1	1	4	80	
Equisetum sp. (arv, hye, or pra)		1				1	20	
Grindelia squarrosa (Pursh) Dunal				1		1	20	
Helianthus annuus L.			1	1		2	40	
Helianthus nuttallii T. & G.		1	1			2	40	
Helianthus spp. (ann &/or nutt)		1	1	1		3	60	
Hordeum jubatum L.	1(3)	1(2)	1(1)	1(2)	1(1)	5	100	1
Juncus alpinoarticulatus Chaix				1		1	20	
Juncus balticus Willd.		1				1	20	
Juncus bufonius L.		1	1	1		3	60	
Juncus longistylis Torr.				1		1	20	
Juncus nodosus L.				1		1	20	
Juncus martenianus Borg.		1				1	20	
Lactuca serriola L.			1	1		2	40	
Medicago lupulina L.				1		1	20	
Medicago sativa L.				1		1	20	
Melilotus officianalis (L.) Lam.	1		1	1		3	60	
Oenothera biennis L.		1				1	20	
Oryzopsis hymenoides (R. & S.) Ricker				1		1	20	
Phleum pratense L.	1	1	1	1	1	5	100	
Poa compressa L.	1	1	1	1	1	5	100	
Poa palustris L.		1	1			2	40	
Poa pratensis L.	1	1	1	1		4	80	
Poa spp. (either com &/or pal &/or pra)	1(4)	1(3)	1(4)	1(3)	1(5)	5	100	2
Polygonum arenastrum Jord. ex. Bor.		1	1			2	40	
Potentilla norvegica L.					1	1	20	
Ranunculus sceleratus L.		1	1	1		3	60	
Ratibida columnifera (Nutt.)		1				1	20	
Raphanus raphanistrum L.				1		1	20	
Rorippa palustris (L.) Besser	1			1		2	40	
Rumex maritimus L.		1				1	20	
Rumex triangulivalvis (Danz.) Rech. f.	1	1	1	1	1	5	100	
Salix spp. (exigua, discolor etc.)		1	1		1	3	60	
Solidago canadensis L. (gigantea ?)				1		1	20	
Symphoricarpos occidentalis Hook.				1		1	20	
Taraxacum officinale Weber	1	1		1		3	60	
Thlaspi arvense L.		1	1		1	3	60	
Tragopogon dubius Scop.		1		1		2	40	
Trifolium repens L.			1			1	20	

Appendix IIc. Species list for wetland area of type 3 wetlands

Open water (submerged and floating aquatic species)

	CR17-C01	OC05-C01	OC05-C02	OC05-C03	CR25-C04	#	%	rank
Filamentous algae	1	1(2)	1(1)	1(1)	1	5	100	1
Likely Cladophora sp.		1	1	1		3	60	
Likely Spirogyra sp.				1		1	20	
Macrophytic algae, *Chara sp.*		1	1(4)			2	40	5
Submergent Aquatic Plants								
Myriophyllum exalbescens Fern.		1(1)	1(3)	1(2)	1	4	80	2
Potamogeton pectinatus L.			1			1	20	
Potamogeton pusillus L.		1				1	20	
Potamogeton (fil,fol, pec,pus or zos)		1(2)	1(1)			2	40	3
Potamogeton richardsonii (Benn.)Rydb.			1(2)		1	2	40	4
Ranunculus circinatus Sibth.			1			1	20	

Emergent species

	CR17-C01	OC05-C01	OC05-C02	OC05-C03	CR25-C04			
Scirpus acutus Muhl. ex. Bigel.			1	1	1	3	60	
Scirpus paludosus A.Nels.				1		1	20	
Scirpus sp. (likely acutus or pal.)			1	1	1	3	60	
Typha lasifolia L.		1	1	1	1	4	80	

Shallow marsh species

	CR17-C01	OC05-C01	OC05-C02	OC05-C03	CR25-C04			
Beckmannia syzigachne (Steud.) Fern.		1		1(5)		2	40	7
Bidens cernua L.				1		1	20	
Carex lanuginosa Michx.		1				1	20	
Carex sp (likely aqu, lanug, ros)					1	1	20	
Eleocharis palustris (L.) R. & S.		1	1	1	1(2)	4	80	5
Glyceria borealis (Nash) Batchelder		1	1(5)			2	40	7
Glyceria grandis S. Wats. ex A. Gray				1		1	20	
Glyceria striata (Lam.) A.S. Hitchc.		1(4)	1	1		3	60	6
Hippuris vulgaris L.			1			1	20	
Limosella aquatica L.					1	1	20	
Phalaris arundinacea L.		1		1		2	40	
Sparganium angustifolium Michx.					1	1	20	

Shoreline and drawdown species (including wet meadow and disturbed species from Millar 1976)

	CR17-C01	OC05-C01	OC05-C02	OC05-C03	CR25-C04			
Achillea millefolium L.		1				1	20	
Agropyron repens (L.) Beauv.	1(2)	1(1)	1(2)	1(1)	1(3)	5	100	1
Agropyron smithii or dasystachyum					1	1	20	
Agropyron trachycaulum or spicatum		1	1	1		3	60	
Agrostis stolonifera L.		1		1	1(4)	3	60	6
Artemisia biennis Willd.		1	1			2	40	
Artemisia frigida Willd.				1	1	2	40	
Artemisia ludoviciana Nutt.			1			1	20	
Aster ericoides L.				1		1	20	
Aster laevis L.				1		1	20	
Aster sp.				1		1	20	
Astragalus sp.		1				1	20	
Avena fatua L.				1		1	20	
Bromus commutatus Schrad.		1		1	1	3	60	
Bromus inermis Leyss.	1(1)	1	1	1	1	5	100	4

Appendix IIc. Species list for wetland area of type 3 wetlands (continued)

Shoreline and drawdown species (including wet meadow and disturbed species from Millar 1976)

	CR17-C01	OC05-C01	OC05-C02	OC05-C03	CR25-C04	#	%	rank
Carex filifolia Nutt.l					1	1	20	
Carex sp (stenophylla-like).		1	1			2	40	
Chenopodium sp.			1			1	20	
Cirsium arvense (L.) Scop.	1(5)	1(5)	1(3)	1(4)	1	5	100	3
Cirsium vulgare (Savi) Ten.		1	1	1		3	60	
Crucifer(alys aly,lepi den,camc mic,card cha)		1	1	1	1	4	80	
Cynoglossum officinale L.			1			1	20	
Deschampsia cespitosa (L.) Beauv.		1			1	2	40	
Descurainia sophia (L.) Webb		1				1	20	
Elymus sp.				1		1	20	
Epilobium ciliatum Raf.		1	1	1	1	4	80	
Equisetum sp. (arv, hye, or pra)		1				1	20	
Grindelia squarrosa (Pursh) Dunal				1		1	20	
Helianthus annuus L.			1	1		2	40	
Helianthus nuttallii T. & G.		1	1			2	40	
Helianthus spp. (ann &/or nutt)		1	1	1		3	60	
Hordeum jubatum L.	1(3)	1(2)	1(1)	1(2)	1(1)	5	100	1
Juncus alpinoarticulatus Chaix				1		1	20	
Juncus balticus Willd.		1				1	20	
Juncus bufonius L.		1	1	1		3	60	
Juncus longistylis Torr.				1		1	20	
Juncus nodosus L.				1		1	20	
Juncus mertensianus Bong.		1				1	20	
Lactuca serriola L.			1	1		2	40	
Medicago lupulina L.				1		1	20	
Medicago sativa L.				1		1	20	
Melilotus officianalis (L.) Lam.	1		1	1		3	60	
Oenothera biennis L.		1				1	20	
Oryzopsis hymenoides (R. & S.) Ricker				1		1	20	
Phleum pratense L.	1	1	1	1	1	5	100	
Poa compressa L.	1	1	1	1	1	5	100	
Poa palustris L.		1	1			2	40	
Poa pratensis L.	1	1	1	1		4	80	
Poa spp. (either com &/or pal &/or pra)	1(4)	1(3)	1(4)	1(3)	1(5)	5	100	2
Polygonum arenastrum Jord. ex. Bor.		1	1			2	40	
Potentilla norvegica L.					1	1	20	
Ranunculus sceleratus L.		1	1	1		3	60	
Ratibida columnifera (Nutt.)		1				1	20	
Raphanus raphanistrum L.				1		1	20	
Rorippa palustris (L.) Besser	1			1		2	40	
Rumex maritimus L.		1				1	20	
Rumex triangulivalvis (Danz.) Rech. f.	1	1	1	1	1	5	100	
Salix spp. (exigua, discolor etc.)		1	1		1	3	60	
Solidago canadensis L. (giganiea.?)				1		1	20	
Symphoricarpos occidentalis Hook.				1		1	20	
Taraxacum officinale Weber	1	1		1		3	60	
Thlaspi arvense L.		1	1		1	3	60	
Tragopogon dubius Scop.		1		1		2	40	
Trifolium repens L.			1			1	20	